Handbook for COTTON GINNERS

Agriculture Handbook No. 260

AGRICULTURAL RESEARCH SERVICE • U.S. DEPARTMENT OF AGRICULTURE

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Contents

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Handbook For COTTON GINNERS

Introduction

DEVELOPMENT OF THE COTTON GIN

By V. L. STEDRONSKY, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

At the time of the American Revolution, the world had only a clothes wringer type of roller cotton gin called "Churka" or "jerka" (*1*). This small hand gin was invented many centuries ago; no one knows when or where. It used two small hardwood pinch rollers less than a foot long, with diameters about the size of a dime and a nickel, respectively. Each roller had its own handle or crank. In models manufactured after 1770, a single handcrank was used at one end only. The rollers were geared together by homemade cogwheels, so that the surface of the small roller would turn about as fast as that of the large one. Both rollers had two bearings that allowed the rollers to be wedged together close enough to grip the cotton fibers and separate them from their seed. This arrangement allowed the fiber to pass between the rollers but held back the ginned seed.

Roller Gin

Before the invention of the McCarthy gin in 1840, roller ginning efforts and ideas were largely centered about the ancient churka type of gin. Attention of the more progressive cotton growers and merchants was centered on manufacturing larger gins with greater capacities than were feasible in the hand-operated gins.

The McCarthy type roller gins have advantages and disadvantages, but they have been used extensively for more than a century to gin many varieties and staple lengths of cotton. They are used almost exclusively in ginning sea-island or American-Egyptian long staple cottons. Cotton mill owners have objected to the use of saw gins for these cottons.

Saw Gin

In 1792 Eli Whitney started to work on developing the saw type gin (*2*). The first working model with wire spikes was tested in 1792 or 1793 by Eli Whitney near Savannah, Ga. In 1796, Hodgen Holmes invented the gin saws and ribs that were adopted by Whitney about 1806.

These inventions of Whitney and Holmes were the beginning of the ginning industry. The cotton gin was a tremendous boon to cotton production, because one machine could do the work of many hand laborers.

But for many years progress was relatively slow. During Whitney's lifetime (1765–1825) and for some years later, gins were handmade in blacksmith shops or in small factories for plantation use. Plantation owners generally were content with a single gin stand with 40 saws of 10-inch diameter. The gin stands were hand fed and were powered by mules or by water. The ginning was separate from the pressing, and all cotton was moved by hand. Lint accumulated in screen wire cages or boxes and later was transferred to a wooden screw, single-box press for baling. This slow and laborious process was the common practice until the latter part of the 19th century.

With the increased demand for gins, gin manufacturing companies began to appear about 1830. Thus, a new industry began. For the next 50 years, improvements slowly continued. By 1884 inventions such as pneumatic unloading devices, separators, feeders, mechanical distributors, lint flues, and condensers permitted the operation of several stands in a battery. These developments, coupled with the double box press, gave birth to the modern cotton gin; and the ginning of cotton became one continuous, uninterrupted system from unloading the cotton at the wagon to pressing the fiber into a bale.

[1] Italic numbers in parentheses refer to Literature Cited, p. 120.

Between 1880 and 1930, the industry's developments centered around such things as better mechanical operation of the gin stand and the machinery in general, improved screen cleaners, and better bur extraction. But there seemed to be small concern about the effects of mechanical treatment on cotton fiber.

In 1930, a new cotton era began with the establishment of the U.S. Cotton Ginning Research Laboratory at Stoneville, Miss. Since that time, the effects of mechanical treatment on cotton quality, fiber characteristics, and spinning performance have been a major consideration in the development of cotton ginning machinery.

ARRANGEMENT OF BUILDINGS AND GROUNDS

By Arthur B. Bond, *extension cotton marketing and utilization specialist, Georgia Extension Service, University of Georgia*

In building or remodeling a gin plan for effective service, consideration should be given to the plant site, yard layout, traffic flow pattern, parking facilities, storage, waste disposal, and plant protection.

Adequate land should be available to provide proper distance between buildings for fire protection, for customer traffic, and for holding loads of

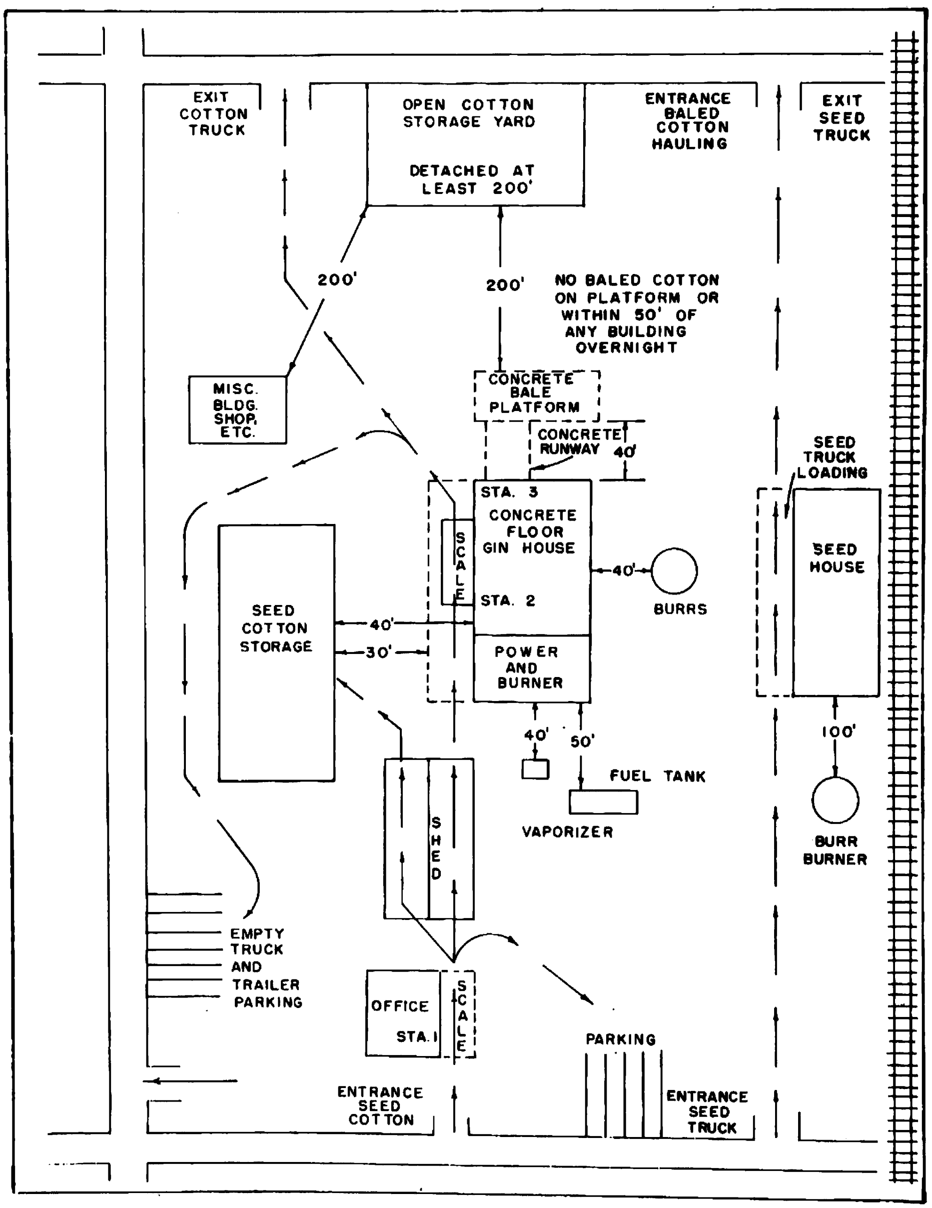


Figure 1.—**Gin yard design showing separate office and minimum safe distances between buildings for protection from fire.**

seed cotton as may be required by harvesting practices. The plant should have access to good roads, powerlines, and potable water. If possible, it should have police and organized fire protection. Also, if the gin is in a town or village, it should be located where the prevailing winds will move dust away from populated areas.

The importance of an adequate water supply piped to strategic locations in the plant and readily accessible chemical fire extinguishers cannot be overemphasized. The safety of plant personnel, the reduced amount of downtime for repairs in case of fire, and the reduced insurance costs make expenditures for fire protection a good investment. Figures 1 and 2 show good gin yard arrangements and minimum safe distances between buildings.

In many instances, the ginner may provide services other than ginning. He may sell seed, fertilizer, insecticides, and other farm supplies. He may buy, condition, and store grain, soybeans, peanuts, or pecans. Each of the services he expects to offer should be given careful consideration in designing the yard layout.

Plant entrances and drives should be designed to group similar traffic. Oil mill seed trucks should not be mixed with trucks loaded with seed cotton. Provisions should be made for ample parking

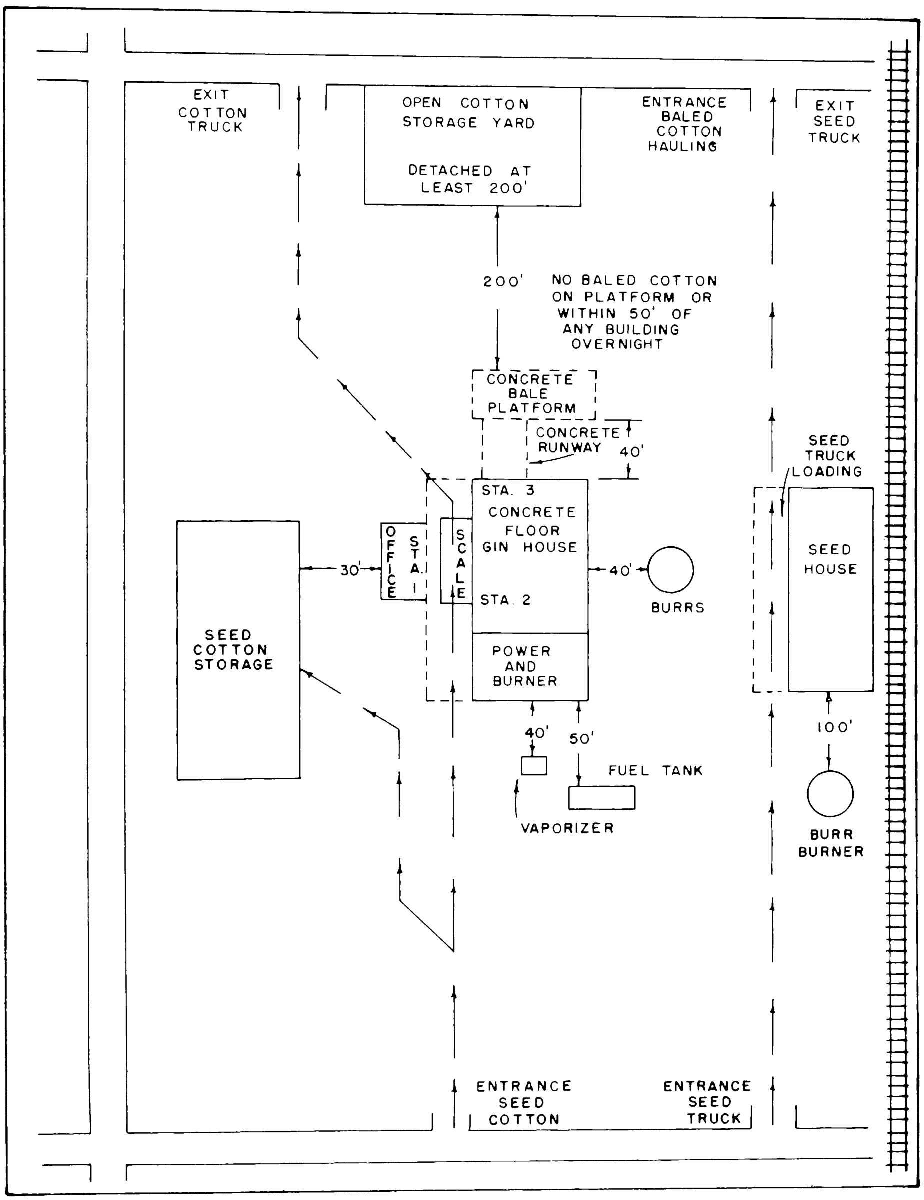


Figure 2.—**Gin yard design with office scales and gin house combined, and showing minimum safe distances between buildings for protection from fire.**

space for empty trucks and trailers left on the gin yard. Space should also be provided for parking automobiles near the office.

The storage space required depends on services to be offered and on industry practices in a particular area. In some areas, the rapid increase in mechanical harvesting has made it necessary for ginners to provide means for storing seed cotton on the gin yard so that farm trailers and motor trucks can return to the field as soon as possible after they are unloaded. Adequate storage facilities also enable the cotton gin to handle peak deliveries of machine-harvested cottons made by night and during weekends. Vehicles should be parked so they can be removed quickly if their load of cotton catches on fire.

Waste collection and disposal at the site with a minimum of dust are desirable in all areas and are necessary in thickly populated areas. Open trash piles and burning trash on the gin yard create a nuisance and are a fire hazard.

EFFECTS OF GIN MACHINERY ON COTTON QUALITY

By A. C. Griffin, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

Lint quality of the cotton in the bale coming from the gin press depends on many factors. Some of these factors are: (1) Variety of cotton; (2) soil type and weather conditions; (3) cultural and harvesting practices; (4) moisture and trash contents; and (5) ginning treatments and processes. Usually, the first four factors exert greater influence on lint quality than do extremes in ginning treatments.

Cotton possesses its highest fiber quality and best potential spinning performance when it is on the stalk. Any mechanical handling, up to and including spinning, may modify the natural qualities or characteristics of cotton. Ginning is a series of thermopneumatic and mechanical processes and, at best, can only preserve those qualities and characteristics that are inherent in the cotton when it enters the ginning plant.

Lint grade, staple length, fiber fineness and maturity (micronaire), and fiber strength—in the order listed—are the factors that determine the selling price of the cotton. Lint grade is determined principally by color and amount of foreign matter present. Ginning processes may do little to change the color of cotton, and they can change the staple length to only a limited extent. Ginning does not affect fineness and maturity.

In addition to its principal function of separating lint from seed, the modern cotton gin is equipped to remove a large percentage of the foreign matter and excess moisture present in the cotton that would seriously reduce the selling price of the ginned lint. Today's ginner must have a twofold objective: (1) To produce ginned lint of grades satisfactory to the grower, and (2) to gin the cotton with minimum reduction in fiber-spinning quality, so that it will meet the demands of its ultimate users, the spinner and the consumer.

Research has shown that, above certain limits, the strength of individual fibers decreases as the fibers become drier and warmer; and that, for a fixed quantity of gin machinery, increased drying may increase fiber breakage and thus reduce length uniformity.

Yarn strength, yarn appearance, and spinning-end breakage are three of the most important spinning quality elements. All are affected by length uniformity and, therefore, by the proportion of short or broken fibers. These three elements are usually best when cotton is ginned with minimum drying and minimum use of other gin machinery.

The relations between gin drying, lint grade, yarn strength, and yarn appearance are shown in figure 3. Grade increases due to drying come from two sources. The grade increase that occurs when moisture is reduced from 8 to 7 percent is due to moving from rough to smooth preparation. When moisture is reduced to 7 percent or lower, grade increases as more foreign matter is removed by the seed cotton and lint cleaners. Further drying gives little grade increase of cotton with 5-percent moisture content or lower.

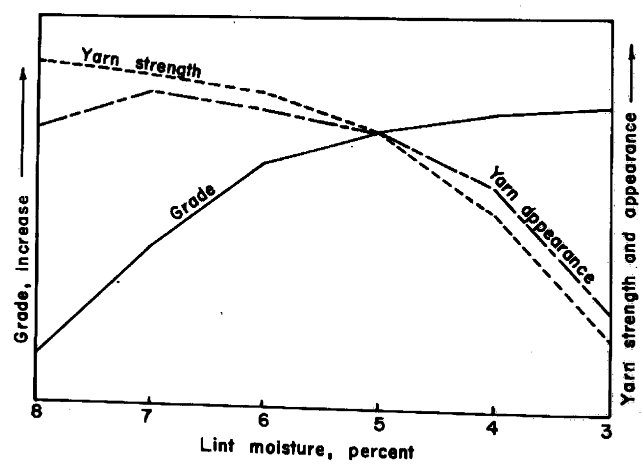


Figure 3.—**Effects of gin drying on lint grade, yarn strength, and yarn appearance.**

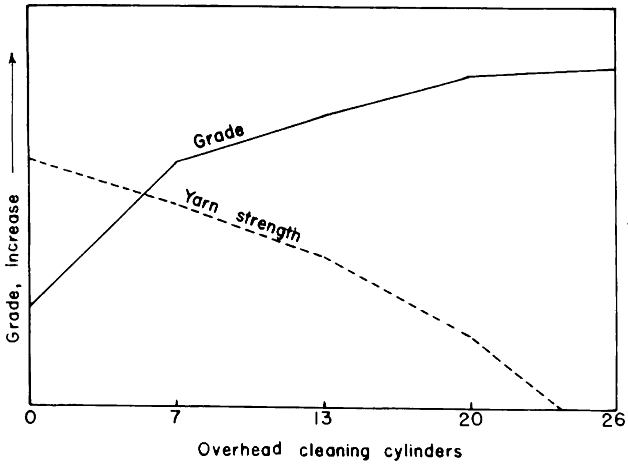


Figure 4.—**The effects of seed cotton cleaners on lint grade and yarn strength.**

Yarn strength continuously decreases as drying increases (or as the fiber moisture content decreases) because of the increased amount of short fiber in the ginned lint. Below the 5-percent moisture level, the rate of fiber breakage increases rapidly.

Yarn appearance improves up to a point because of increased foreign matter removal. But the effect of increased short fiber content (and perhaps other factors) overshadows the benefits resulting from foreign matter removal.

The effects of seed cotton cylinder cleaners on lint grade, yarn strength, and yarn appearance are shown in figures 4 and 5.

As the number of cleaning cylinders increases, the lint grade usually increases. Cleaning efficiency of each cylinder is relatively constant; less foreign matter is removed and less grade improvement is expected from each succeeding cylinder. Twelve to fourteen cylinders are considered adequate when two lint cleaners are used and the cotton is dried to the 5- to 7-percent fiber moisture level. The first cleaner should not contain more than seven cylinders to prevent roping of inadequately dried seed cotton. The yarn strength decreases steadily as the number of cleaning cylinders increases.

For cleanly picked cotton, the yarn appearance curve also shows a steady downward trend because of the machined effect; whereas the machine-picked cotton curve shows an upward trend because of foreign matter removal, until the machined effect overrides the foreign matter effect at about 13 cylinders (fig. 5).

The effect of lint cleaning on lint grade, yarn strength, and yarn appearance is shown in figure 6. Lint grade classification shows some grade increase as the number of lint cleaners increases, but each succeeding lint cleaner gives less grade improvement than the preceding one. In addition to removing fine trash, the lint cleaners often blend light spotted cotton so that it passes into the white grades. The lint cleaners also remove some short fiber. Hand stapling and machine measurements often show a slight increase in length. This length increase usually reduces manufacturing waste but has little, if any, effect on yarn strength.

Yarn appearance is usually affected adversely by lint cleaner treatment. The effect is usually

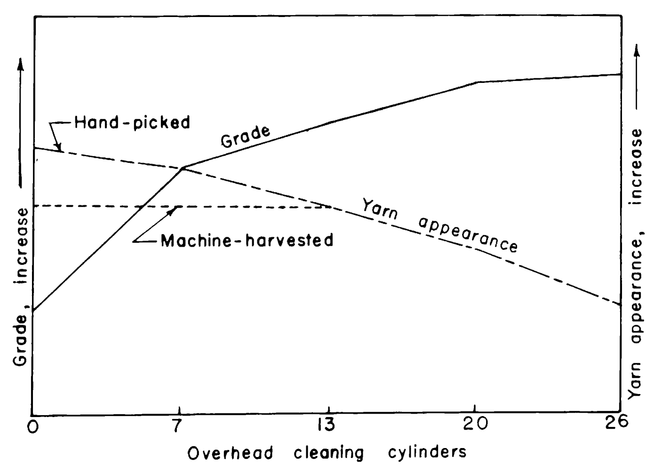


Figure 5.—**The effects of seed cotton cleaners on lint grade and yarn appearance for hand-picked and machine-picked cotton.**

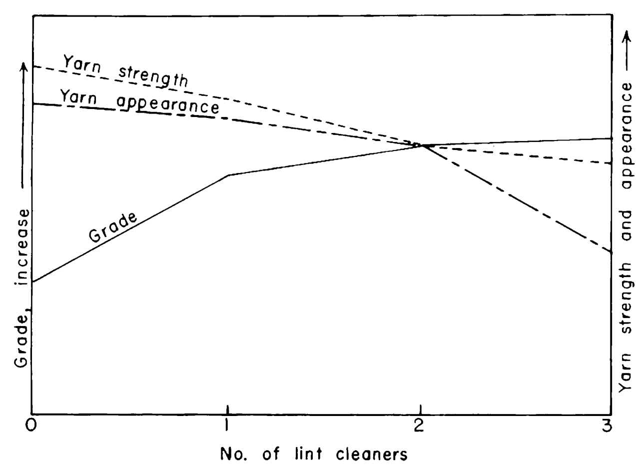


Figure 6.—**Effect of lint cleaners on lint grade, yarn strength, and appearance.**

slight when only one or two lint cleaners are used, but yarn appearance declines rapidly as additional cleaners are used.

The overall effect of the ginning processes on grade and yarn quality is shown by the chart in figure 7. This chart shows the effects of gin drying and four different combinations of machinery on lint grade and yarn quality. Because of the usually rapid decline in lint grade improvement and in yarn quality after the 14-cylinder and 2-lint cleaner combination is used, that combination is recommended as the maximum ginning machinery acceptable to produce lint grades compatible with acceptable yarn quality. Use of this machinery combination results in little grade improvement in low-moisture cotton as compared to high-moisture cotton; whereas the spinning quality of low-moisture cotton rapidly decreases as additional machinery is used.

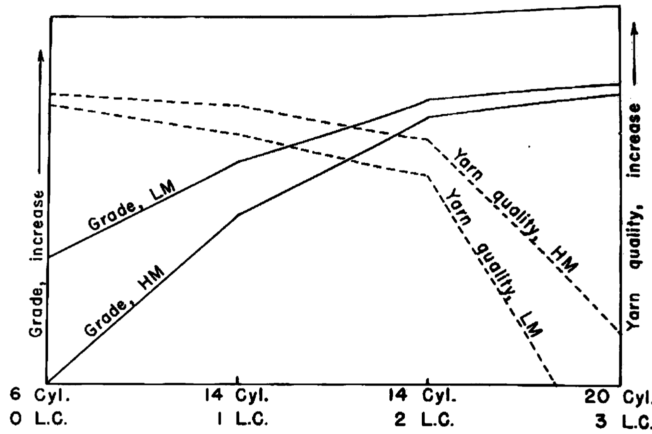


Figure 7.—**Effects of seed cotton cleaning and lint cleaning on lint grade and yarn quality for cotton of two fiber-moisture levels during gin processing. Yarn quality includes yarn strength, yarn appearance, and spinning breakage.**

Growing and Harvesting for Quality Ginning

COTTON CHARACTERISTICS AS RELATED TO GINNING

By W. E. CHAPMAN, *cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

Although methods of ginning can affect certain cotton lint characteristics, there are certain cotton characteristics that affect ginning, cleaning efficiency, and ginning capacity.

Cotton varieties with relatively greater resistance to diseases (particularly boll rots), with plant characteristics suitable for mechanical harvesting, and with fewer hairs on leaves and other plant parts are more easily cleaned in the gin than are cottons with opposite characteristics. Cottons free of boll rots and naturally clean cottons gin at greater capacity than do cottons with diseased bolls that are hard to clean.

Generally, the inherent cotton characteristics that contribute to high grade also contribute to greater ginning capacity. Well-matured cottons tend to contribute to increased capacity.

Inherent strength of attachment of fibers to seed affects ginning capacity; cottons with relatively weak tenacity, or strength of attachment, gin with greater capacity.

Cottons that contain a low percentage of linters gin at greater capacity than do cottons that contain a high percentage of linters.

Inherent fiber characteristics associated with high ginning capacity are relatively high fiber length uniformity, high tensile strength, and high micronaire values. For a given variety, high micronaire indicates good fiber maturity.

PREPARING FOR HARVEST

By R. F. COLWICK, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Cultural practices that may influence cotton harvesting operations vary widely across the Cotton Belt largely because of differences in soil and weather conditions. Local agricultural experiment stations should be consulted for specific recommendations dealing with various aspects of cotton production such as selection of varieties to be grown, fertilization rates, irrigation practices, weed control methods, and insect control.

Selecting the field and preparing the land are important steps in preparing for harvest. The land should be well drained and the fields laid out for effective use of machines. Residue from previous crops should be shredded sufficiently in the fall to discourage insect hibernation and to promote decay during the winter. Turn rows should be smoothed out at least 20 feet wide to allow the harvester to enter the rows properly and at normal operating speed.

Uniform stands of 30,000 to 50,000 plants per acre encourage the growth of the plant type best suited for mechanical harvesting. Because grass is difficult to remove in the gin, the fields should be kept clean. The shape or profile of the rows has a bearing on the amount of trash in machine-harvested cotton. The last cultivation should leave the row elevated 2 or 3 inches with the slope away from the base of the plants on each side. Large, late-fruiting plants should be avoided, since they encourage lodging, boll rot, and difficult defoliation.

Removing the leaves from the cotton plant with chemicals can minimize green leaf trash in mechanically harvested cotton. Defoliants cause the plants to shed their leaves, and desiccants kill the plant tissue. In most areas where the picker-type harvester is used, defoliants should be applied when at least 60 percent of the bolls are open. All bolls should be mature and about 90 percent open before desiccants are applied.

HARVESTING

By R. F. COLWICK, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Moisture in machine-harvested cotton can be kept at a minimum by proper timing with respect to weather. The moisture of seed cotton varies directly with the relative humidity of the air around the plant. Seed cotton cannot be harvested safely in the morning until the lint has reached a moisture content of 10 percent or less on the plant. In some areas, this does not occur until 9 or 10 a.m. on a clear day. If cotton is picked before it has dried to a moisture level for safe storage, it should be ginned immediately. The amount of trash or leaf harvested by the machine has a direct bearing on the total moisture content. Trash, whether it is green or dry, usually has a higher moisture content than does the harvested seed cotton. As soon as the trash and seed cotton are mixed together, they approach equilibrium in moisture content; and the harvested material may rapidly become too damp to store or gin properly.

Proper care of the harvesting machine is important in controlling trash and moisture. Before the season begins, worn parts should be replaced and all adjustments to factory specifications should be made by trained personnel.

With the spindle picker, cleanliness is most important. The manufacturer's lubrication guides should be followed, and excess oil and grease should be cleaned from the machine after each lubrication of the picking head. If oil and grease accumulate in the picking head, the head should be scrubbed down with a cleaning solvent.

With the stripper-type machine, the plant lifters and stripping rolls should be adjusted and operated to pick up a minimum of trash and foreign material from the ground and bark and branches from the plants. If the stripper is equipped with an air blast or other boll-separating device, it should be adjusted to remove as many green bolls as possible for early before-frost stripping of defoliated or desiccated cotton to prevent excessive moisture and heating.

The skill and training of the operator play a large part in harvesting clean, dry cotton. Each time the spindle-type picker stops to dump the basket, the operator or a helper should clean out the picker head doors and drum area by hand. He should also keep the picker basket free of lint streamers. Lint streamers should never be thrown or allowed to drop into a trailer of seed cotton.

Most of the spindle twists or "bow-ties" that plague ginners are caused by improper adjustment of the spindle moistening pads and doffers. These adjustments should be checked visually every time the machine stops to dump. Improper adjustment is also evidenced by poor picking efficiency or dirty spindles, or both. Grass and green leaves wrapped tightly in the twist of seed cotton encourage spindle twist.

The pressure plates in the picker head should be set with a clearance and tension to suit the size and condition of the cotton being picked. If the plants are small and most bolls are open, the pressure plates can be set one-fourth inch from the tips of the spindles with a yield pressure of 40 pounds to increase picking efficiency. If the plants are large and green, and if there are many green unopened bolls, the clearance can be increased to as much as three-fourth inch and the yield pressure reduced to 20 pounds. This adjustment will minimize the loss of green bolls but will reduce the machine efficiency in the first picking.

The amount of moisture added to the seed cotton by the picker can be kept at a minimum of only 1 to 2 percent if care is taken in adjusting the spindle moistening pads and the flow of water to them. Only enough water should be used to keep the spindles clean. The flow should be adjusted throughout the day, since less will be required early in the day and late in the afternoon, when the seed cotton moisture is higher. Wetting agents in the water often help keep spindles clean with slightly lower water rates. Textile oils are used in some areas instead of water for spindle moistening. Tests have shown that oils keep the spindles and picker head clean but lower the picking efficiency of the machine. Also, the small amount of oil left in the lint after ginning is not desirable to the spinning mills.

Considerable interest has developed recently in gleaning cotton dropped to the ground by mechanical harvesters. Several gleaning machines are available for this operation. The foreign matter picked up with the seed cotton by these machines often requires special handling in the gin and creates ginning problems. The answer to this problem would be better control of production and harvesting practices and better harvesters to improve harvesting efficiency. By these means, the gleaning operation would be unnecessary. Until these improvements are made, however, gleaning will be used in some areas.

SEED COTTON STORAGE

By A. C. Griffin, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

Seed cotton storage is defined as the holding of harvested seed cotton until it is fed into the ginning system. Regional methods vary, but where the harvesting rate exceeds the ginning rate, two methods of storage—house storage and trailer storage—are most generally used. House storage may be either on the farm or at the gin; but trailer storage is customarily at the gin.

The greatest problems in storing seed cotton are those of preventing downgrading of lint because of color changes and seed deterioration. Color changes may be of two types—spotting and dulling. Spotting while in storage has been traced to transfer of tannins in the seedcoat to fibers. Fiber staining by chlorophyll in leaf particles takes place when leaves are crushed against fibers during harvest; it is not due to chlorophyll transfer from uncrushed leaves during storage. Color dulling may be due to bacterial action, but spotting during storage has not been traced to this cause except with very wet cottons. In the majority of cases where spotting (due to seedcoat disintegration) occurred, the cottons underwent spontaneous heating for several days.

Seeds in a load of seed cotton behave similarly to seeds in seedpiles; that is, their biological processes take place whether or not the fibers are attached to the seeds.

Moisture is the predominant factor in determining the degree of biological activity in cottonseed and, all other factors being equal, is responsible for the spontaneous heating of seed cotton in storage.

In predicting whether seed cotton may be safely stored, the 12-percent seed moisture content is a rough dividing point. Seed cotton with seed containing less than 10 percent of moisture may be safely stored, but seed cotton with seed containing more than 14 percent of moisture may be expected to stain. Seed cotton with seed in the 10- to 14-percent range may or may not suffer degradation, depending on other factors such as fiber moisture level, degree of seed deterioration before delivery to the gin, and size of load.

In short, keeping prime seed cotton in storage without quality damage is more a matter of drying to a safe storage level than cooling after heating has begun.

House Storage Considerations

Cotton dry enough for safe storage may be blown into storage houses at a rate up to 100 pounds per minute, using a size 45/40 cone-type Rembert fan or an appropriate dropper system. The need for bins depends on whether cottons must be segregated by ownership or by variety, or for some other reason. The size of storage house depends on the individual needs; machine-picked cotton pneumatically loaded into the house requires approximately 250 cubic feet of bin space per bale. House storage is not proposed as a means for obtaining grade improvement but is intended, where safe storage is feasible, to release trailers for the harvesting operation. Except where planting-seed is involved, no conditioning of cotton before storage is recommended, since machinery and space required would represent a sizable investment. If the moisture content of seed cotton is 14 percent or above, the cotton should be ginned promptly.

At least two unskilled laborers are required to operate a storage house. Putting a bale of cotton into the house and then removing it for ginning will require as much as 1½ man-hours of labor.

Reasonable precautions should be taken to protect seed cotton in storage, and stored seed cotton should be insured against fire. Many factors enter into the fire insurance rate structure of a seed cotton storage house. Among them are the presence of heaters, internal combustion engines, and electric motors in the building; the condition of the electrical wiring and equipment; the watchman's service; and the availability of public and private fire protection. Generally, farm-stored cotton may be insured against fire at rates lower than those of cotton stored in a building on the gin premises. For further information on fire insurance, see section on Fire Insurance Considerations, p. 113.

Trailer Storage Considerations

Three alternatives to seed cotton house storage are: (1) Provide additional ginning capacity through supplying additional gin stands, increasing operating efficiency, and operating 24 hours a day; (2) reduce the harvest rate; and (3) provide additional trailers for gin yard storage.

Trailer storage problems are unlike house storage problems in some respects. Handling costs (labor and machinery) for trailer storage are low compared to those for house storage, but the reaction of damp seed cotton to heat damage is identical.

When cottonseed respires (either as seed only or in the seed cotton form), heat is generated. If the heat cannot be dissipated as rapidly as it is generated, the seed cotton is warmed and the heating process is accelerated.

Trailer storage tests were conducted using 4-bale loads of cotton that were treated by drawing ambient air through the load after heating began. This treatment cooled the load but had no noticeable effect on the tendency to reheat or on fiber discoloration. The treatment dried some of the cotton at the top of the load but increased the moisture content of that near the bottom of the load at the suction duct. These tests showed a need for special trailer construction for forced air movement. They also showed that cost of power and sufficient equipment for large-scale application might be prohibitive. The high power requirement for suction aeration results from fiber packing and clogging duct screens or perforations. Tests involving blowing air through the trailer from the bottom of the load were impractical because the load separates into air channels that effectively short circuit the load. Channel paths are preformed because of the manner in which mechanical harvester baskets are dumped into trailers. Other tests showed that, in seed cotton with dry seed and wet fiber, the moisture in the fiber could be transferred to the seed and initiate seed heating.

Transfer of cotton from one trailer to another through a gin-type drying system will remove some fiber moisture but will have little immediate effect on seed moisture. This method of preparing seed cotton for storage is sometimes satisfactory for cottons with damp fiber and with seed having 10-percent moisture content or below. If this method is used, drying air temperatures must be carefully controlled because the gin drier may leave residual heat in the cotton. Thus, more harm than good can result from borderline moisture conditions.

The following facts should be of value to producers and ginners who use short-term storage:

(1) Large lots of cotton are more difficult to store without damage than are small lots. Surface exposure to hasten drying and to permit heat dissipation influences load behavior.

(2) Trailers with slotted or mesh walls are preferable to those with sheet or solid walls in preventing localized high-moisture concentrations caused by trapped moisture condensing on trailer walls.

(3) Cottons harvested when relative humidity is above 50 percent should not be considered safe storage risks unless they are carefully dried before storing.

(4) Cottons known to be damp should be so marked and sent to the gin for immediate ginning.

(5) Early morning harvestings should be loaded on separate trailers, so that, if gin yard storage is necessary, cottons harvested in the middle of the day should be selected for storage.

(6) Transferring cotton from one trailer to another with ambient air when the relative humidity is low has dried mature, machine-picked cotton satisfactorily in low humidity areas.

SEED COTTON GROUPING

By A. C. Griffin, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

Conventional gin drying systems that do not have adequate controls cannot be regulated quickly enough to prevent overdrying or underdrying the cottons. Under some conditions, at least one bale of cotton may be ginned or considerable ginning time lost before the heat can be adjusted to properly dry bales of different moisture contents. Therefore, a difficult problem for the ginner arises when trailers of relatively dry hand-picked cotton and trailers of damp machine-picked cotton are intermixed in line on the gin yard. If the cotton in each trailer is ginned as it is received, without regard to moisture content, as has been the custom for years, some cotton is overdried and some is underdried; and there is a loss of quality.

The producer and ginner working together can avoid loss in time for the ginner; can speed up the emptying of trailers; and can eliminate overdrying and underdrying, with their attendant losses, by working out a seed cotton grouping program.

Table 1 shows the results of properly grouping cottons for ginning.

When there is excessive drying of hand-picked cotton, the ginner loses because production is reduced, fuel costs are increased, press difficulties are encountered, and customers may be dissatisfied. The mill also loses when the cotton is overdried because fiber length uniformity, tensile strength, and yarn strength are reduced and manufacturing waste is increased.

If machine-picked cotton is inadequately dried, the ginner loses because of possible choke-ups, poor samples, and customer dissatisfaction. The mill also loses because fiber length uniformity and yarn appearance grade are reduced and manufacturing waste is increased.

Table 1.—*Effect of grouping seed cotton for ginning*

Item	Hand-picked cotton (8–9 percent moisture)		Machine-picked cotton (11–12 percent moisture)	
	When ginned correctly [1]	When ginned immediately after machine-picked bale is ginned correctly	When ginned correctly [1]	When ginned immediately after hand-picked bale is ginned correctly
Grade	Middling	Strict middling	Strict low middling	Low middling
Staple ... inch	$1\frac{1}{16}$	$1\frac{1}{32}$	$1\frac{1}{16}$	$1\frac{1}{16}$
Lint moisture ... percent	6–7	3–4	5–6	7–8
Bale weight ... pounds	500	[2] 481	500	[3] 523
Lint value [4] ... dollars	34.39	34.34	32.09	29.99
Bale value ... do	[5] 171.95	165.18	[6] 160.45	156.85
Net loss to be saved by grouping for proper ginning ... dollars	----------	6.77	----------	3.60

[1] According to USDA Ginning Laboratory recommendations.
[2] Weight loss due to removal of moisture and trash.
[3] Weight gain due to extra moisture and trash.
[4] Per pound, 1961 loan, average location.
[5] If plated, bale would grade Strict low middling $1\frac{1}{32}$. Loss would then be $21.20.
[6] Rough preparation could reduce grade to Strict good ordinary $\frac{1}{16}$. Loss would then be $13.02.

Ginning Process

SEED COTTON INPUT CONTROL

By O. L. McCaskill, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

The need for a controlled, uniform feed for proper gin stand operation was recognized early in the development of the cotton gin. As the amount of seed cotton cleaning equipment was increased to handle roughly hand-picked and machine-harvested cotton, it became more apparent that some type of metering system was necessary to: (1) Minimize chokages in seed cotton cleaners, (2) provide an even flow of cotton to the driers and cleaners for efficient operation, (3) minimize fiber damage, and (4) decrease time loss between bales.

A seed cotton feed-control unit was developed by the USDA to meet this need (*7*). The unit consists of a surge bin or hopper, with variable speed feed rollers located in the bottom of the hopper to feed the cotton into the gin conditioning and cleaning system (fig. 8). The hopper is large enough to hold one-third of a bale of seed cotton. To prevent overfilling the hopper, pressure switches are installed in the hopper to control the valve in the unloading fan line (fig. 9). Installing the feed control as shown in figure 9 has a number of advantages. This arrangement makes it possible to use the separator in the wagon suction line for handling the overflow, without installing a great amount of extra pipe. It also makes it possible to feed the overflow directly to the conveyor distributor. The ginning research laboratories do not recommend placing the feed control in the overflow pen. Such an arrangement enables cotton to recirculate through the drying machinery and overhead cleaning equipment and results in overdrying, overcleaning, fiber damage, and two-sided bales.

CONDITIONING

By C. G. Leonard, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

Drying

The moisture content of seed cotton is very important in the ginning process. Seed cotton having too high a moisture content will not clean or gin properly, and prime quality seed cotton dried to subnormal moisture contents will be damaged by ginning.

Cotton is hygroscopic. Dry cotton placed in air of high relative humidity (damp air) will gain moisture, whereas wet cotton placed in air of low relative humidity (dry air) will lose moisture. Both constituents of seed cotton—fiber and seed—are hygroscopic, but at different levels (fig. 10). For every value of ambient air relative humidity, there is a corresponding equilibrium moisture content for the seed cotton, fiber, and seed. For example, if seed cotton is placed in air of 50-percent relative humidity, the fibers will tend to reach a moisture content (wet basis) of approximately 6 percent; the seed will tend to reach a moisture content of about 9 percent; and the composite mass will approach a moisture content of 8 percent. The temperature of the air at a given relative humidity influences the equilibrium moisture content only slightly.

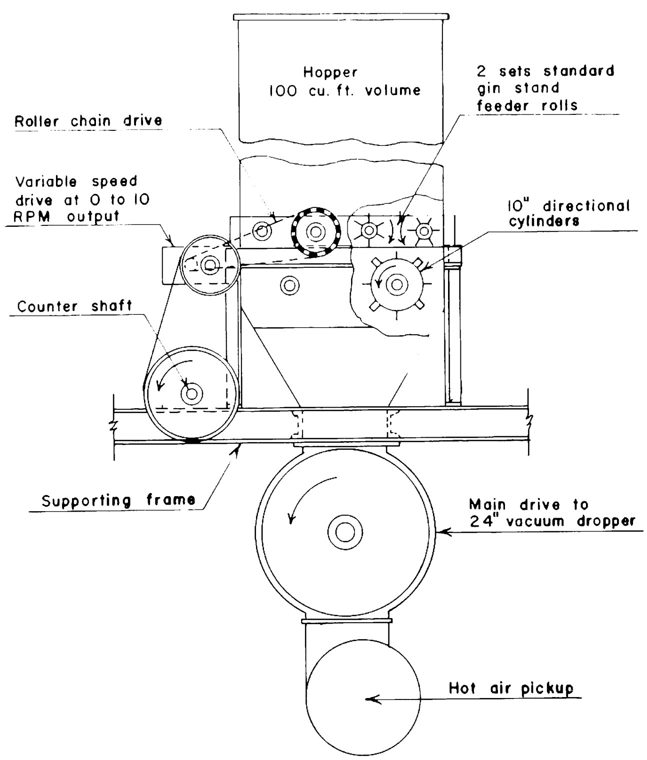


Figure 8.—**USDA-designed automatic feed control unit.**

Moisture occurs in the fibers and seed (hygroscopic moisture) and sometimes on their exterior surfaces (surface moisture). The ratio of the hygroscopic to the surface moistures varies considerably unless the cotton has been stored for some time in an atmosphere of constant relative humidity. There is no fixed ratio between the moisture contents of the fiber, seed, and trash of the seed cotton due to the influence of weather, method of harvest, and time of storage between harvesting and ginning. Seed cotton that is damp or wet from rain or dew may have excessive surface moisture, whereas seed cotton exposed to damp or rainy weather and its attendant high relative humidity will have a relatively high hygroscopic moisture content.

Drying can be accomplished at gins by using either ambient or heated air. For drying, the relative humidity of the air must be equal to or less than the relative humidity that corresponds to the desired equilibrium moisture content of the seed cotton (fig. 10). For example, to dry seed cotton to an equilibrium moisture content of 10 percent, the relative humidity of the drying air must be 65 percent or less. Cotton does not dry at a constant rate but at a falling rate; that is, the drying rate is highest at the beginning of the drying period and decreases as the cotton is dried.

Artificial drying is more effective in removing moisture from the fibers than is indicated by the amount of moisture removed from the seed cotton. Most of the moisture removed during the short time of exposure in commercial gin driers comes from the fibers rather than from the seed and trash. The seed comprises about two-thirds of the weight of seed cotton. Results from moisture tests (by the oven method) of seed cotton, especially where the cotton has been artificially dried, do not necessarily indicate the ginning condition of the fibers. The moisture content of the seed is considerably less important from a ginning standpoint than the moisture content of the fibers, unless the seeds are so wet that they are soft or mushy. For satisfactory ginning, seed moisture content should not exceed 14 to 16 percent.

The factors that control the rate and amount of drying are: (1) Temperature and relative humidity of the drying air, (2) volume and velocity of the drying air, (3) exposure time, and (4) moisture content of the cotton entering the drier.

The moisture in and on the cotton exerts a vapor pressure that is determined by the temperature

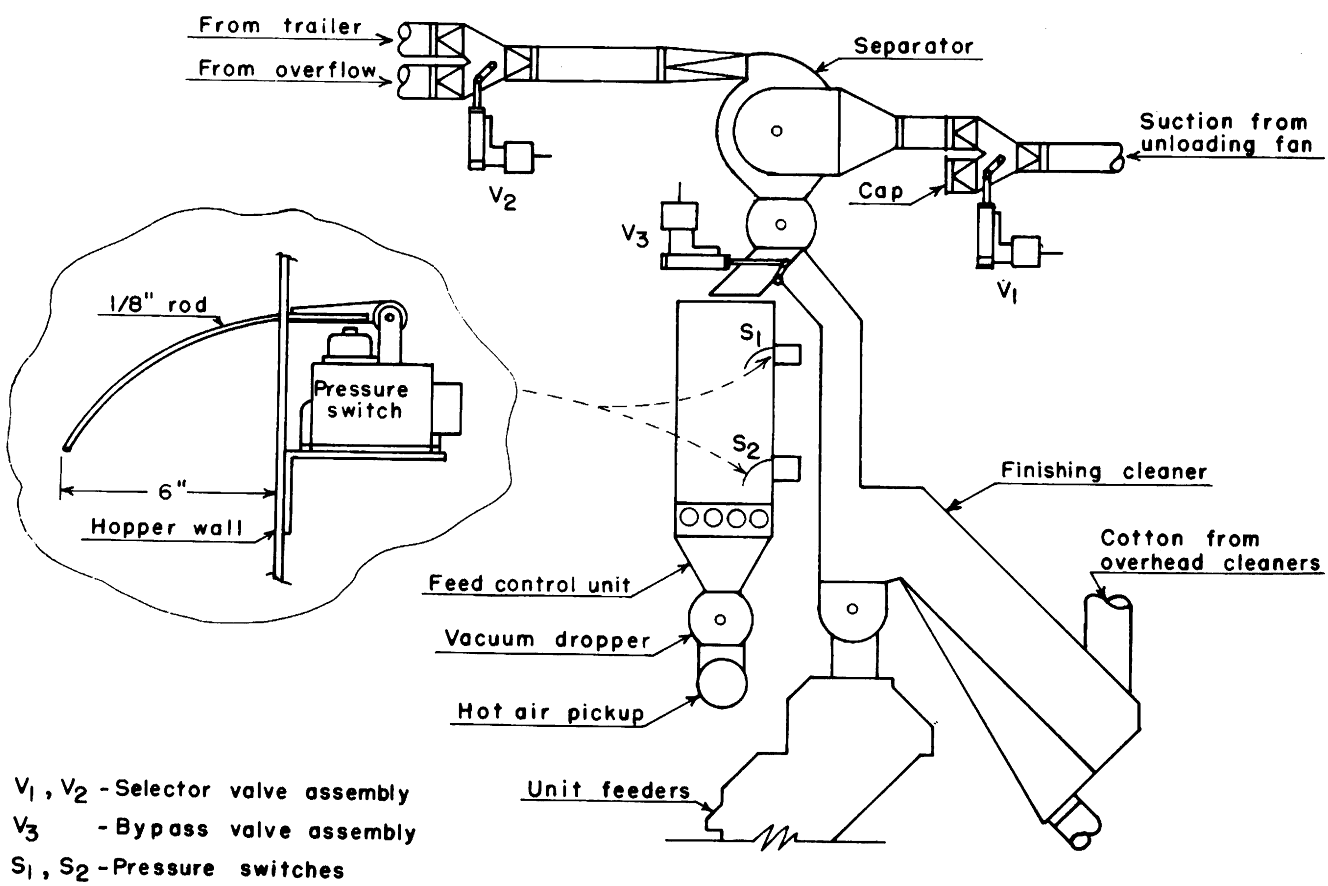


Figure 9.—**Diagram of feed control installation showing details of control switch.**

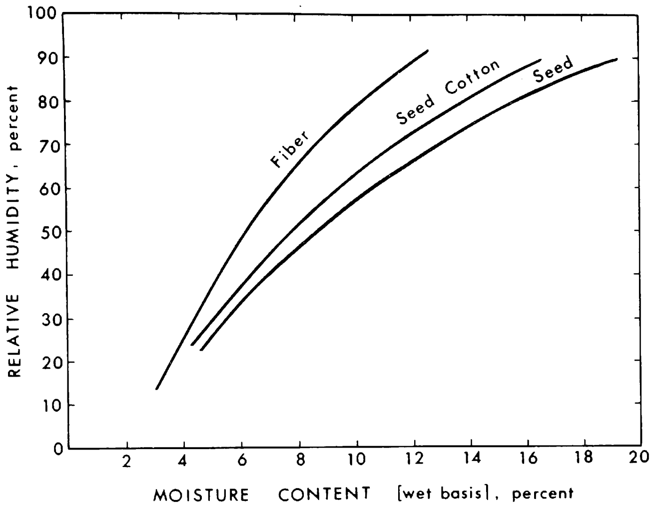


***Figure 10.*—Equilibrium moisture contents of cotton fiber, seed cotton, and seed at different relative humidities.**

and cotton moisture content. If the water vapor pressure in the surrounding air is less than the vapor pressure of the moisture in the cotton, drying will occur.

The driving force that removes moisture is the difference in the vapor pressures—vapor pressure due to the moisture of the cotton and vapor pressure due to the water vapor present in the drying air. The greater the difference, the faster the drying. After ordinary air reaches temperatures of 180° to 200° F., the relative humidity decreases more and more slowly with additional temperature rise; however, the vapor pressure of water increases rapidly. The drying force (vapor pressure difference) increases with rising temperatures, whereas the relative humidity decreases. At the start of the drying process, the higher the drying air temperatures, the greater the difference in vapor pressures and the faster the rate of drying. If portions of cotton of similar moisture content are placed in atmospheres of equal relative humidities but different temperatures, the drying rate will be greatest for the portion placed in the atmosphere of highest temperature. However, all portions will approach the same final moisture content.

The rapid decrease in the relative humidity of air of constant moisture content as the temperature increases is shown in figure 11. After the air reaches temperatures between 150° and 200° F., the relative humidity decreases more slowly. With volumes of air used in parallel flow driers, such as the USDA-designed tower drier, after the moisture removed from the cotton has been added to the air, the relative humidity at the drier outlet remains comparatively low unless the temperature drop of the system is excessive. Figure 12 shows the temperature drop measured between the inlet and the outlet of an 18-shelf tower drier with no cotton in the system. The introduction of seed cotton into the drier would cause a further temperature drop because of the heat used to raise the temperature of the seed cotton to remove moisture.

The changes that occur in the temperature and relative humidity of the drying air during the operation of a typical single-stage drier are shown by the curves in figure 13. As the air and seed cotton move through the drier, the temperature will drop because of: (1) Heat radiation and conduction losses; (2) heat used to increase the temperature of the mass of seed cotton and foreign matter; and (3) heat used to vaporize or remove the moisture from the cotton. The temperature of the fibers will increase until, some time after initial exposure to the drying air, it will be approximately the same as the surrounding air.

Cotton should never be dried at a temperature higher than necessary. Laboratory tests have shown that fibers will sometimes scorch at temperatures below 450° F., and they always scorch at 500°. Ignition may occur at 450° with long exposures, and it may occur almost instantaneously at temperatures of 550° to 600°.

The air velocities and volumes necessary for proper operation of seed cotton driers vary considerably, depending on the type of drier and the rate of ginning (number of pounds of seed cotton to be dried per minute).

In parallel-flow driers such as the tower type, where the drying air is also the conveying medium, the velocity must be sufficient to assure continuous flow. It should be between 4,000 and 4,500 feet per minute in the cotton conveying piping, and above 900 feet per minute within the tower to handle heavy, damp seed cotton. A tower drier can operate satisfactorily using from 100 to less than 40 cubic feet of air per pound of seed cotton. The volume of air (c.f.m.) must be sufficient to act as a heat carrier without having too large a temperature drop, and the quantity of air must be sufficient to remove the desired weight of moisture without having the relative humidity increase too much. Increasing the air volume while keeping other things constant will make more heat available for increasing the seed cotton temperature and will maintain a lower relative humidity. But it will increase the air and seed cotton velocities, thus reducing the exposure time, unless the cross-sectional areas of the drier and piping are increased.

In counterflow-type driers, the air velocity must be kept low enough to allow the seed cotton to proceed through the drier against the resistance of the air flow. But the air volume must be sufficient to assure proper drying.

When increasing the ginning capacity of a plant, a drying system must be provided that will insure adequate volumes of air for conveying the seed cotton (in parallel-flow driers) and for drying the additional amounts of seed cotton to be processed. Unless the drier size is increased proportionately, the air velocities will become high, exposure time will be short, and temperatures will be excessively high.

At present, the only practical control over exposure time is to pass the seed cotton back through the drier or to use more than one drier in series. There is automatic exposure control to a limited extent in all parallel-flow driers that utilize the drying air as the conveying medium because damp cotton will travel through the system more slowly than will dry cotton.

The USDA has recently developed a multipath drier to control drying by controlling exposure rather than by controlling drying air temperature. This drier (fig. 14) is constructed so that the cotton may be directed three ways—through the full, long path; through the middle path, using half of the tower; or through the short path, using only the last shelf of the tower and the associated piping. Typical exposure times for these three paths are 10, 6, and 2 seconds, respectively.

When driers are used in series, laboratory tests have shown that identical amounts of drying will be obtained whether the first drier with a high inlet temperature and the second drier with a low inlet temperature are used, or the first drier with a low temperature and the second drier with a high temperature are used (table 2). A common practice is to run the first drier at a higher temperature than the succeeding ones. However, to prevent any possibility of quality damage from the higher temperature, all driers should be operated at nearly the same inlet temperature.

Seed-moisture contents of two cottons having initial wagon moisture contents of 9.4 and 6.7 percent were determined after the cottons were dried once, twice, and three times in an 18-shelf drier using two inlet temperatures (fig. 15). Less moisture was removed with each succeeding pass. It is easier to remove moisture from cotton with a high-moisture content than from cotton with a low-moisture content. More heat energy is required

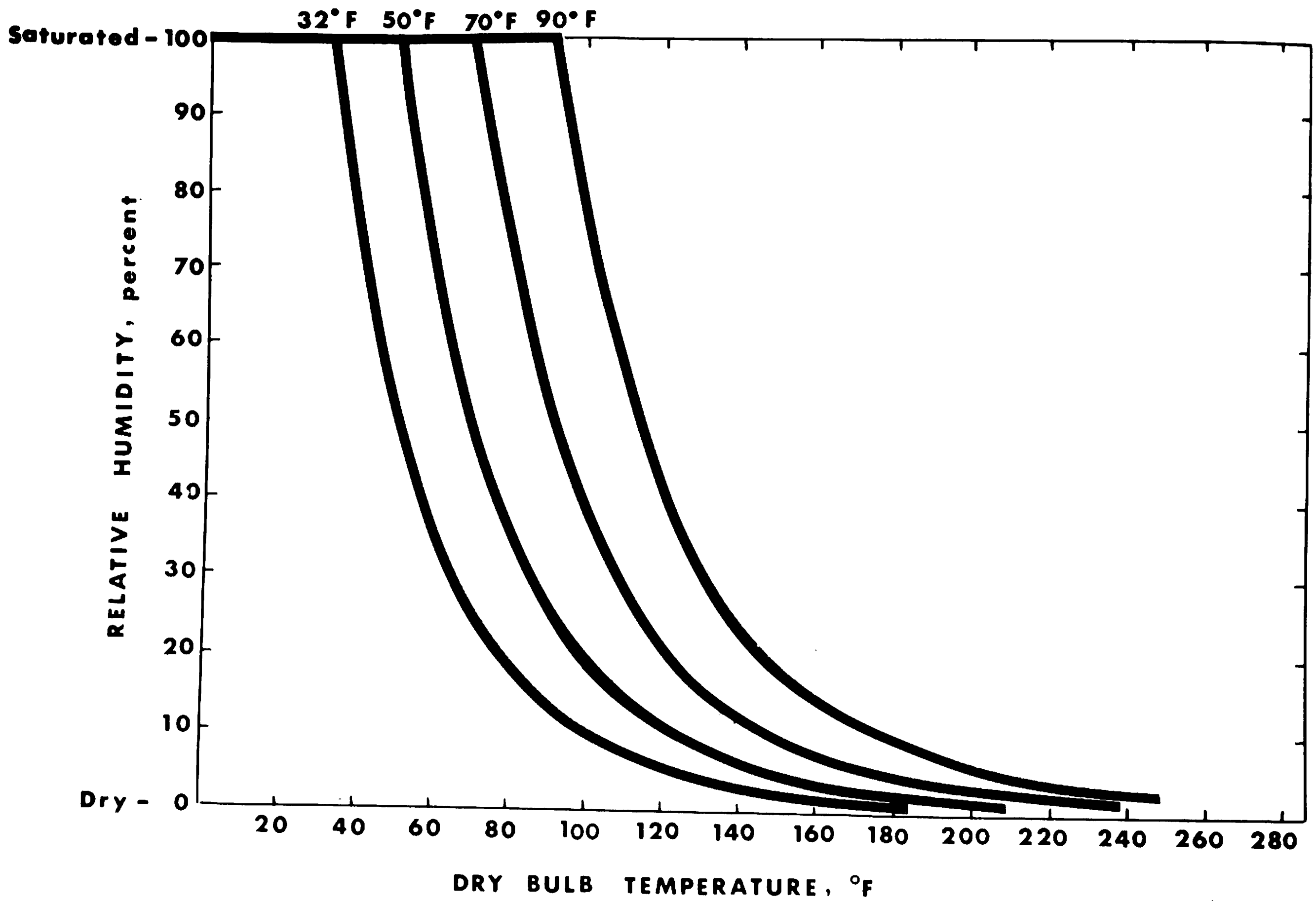


Figure 11.—Effect of temperature on the relative humidity of air of constant absolute humidity. Atmospheric pressure of 29.92 inches of mercury.

TABLE 2.—*Moisture contents produced by passing seed cotton through an 18-shelf drier twice, using three combinations of inlet drying air temperatures*

Drying air temperature at inlet to drier		Moisture contents (wet basis)		
		Seed cotton		Lint
1st pass	2d pass	Wagon	Feeder	
HAND-PICKED, EARLY SEASON, IRRIGATION GROWN IN NEW MEXICO				
°F.	*°F.*	*Percent*	*Percent*	*Percent*
150	350	11. 4	8. 6	4. 3
350	150	11. 4	8. 6	4. 3
250	250	11. 8	9. 2	4. 6
HAND-PICKED, AFTER FROST, IRRIGATION GROWN IN ARIZONA				
150	350	6. 7	5. 7	3. 2
350	150	6. 9	5. 7	3. 2
250	250	6. 9	5. 8	3. 0

to remove equal increments of moisture as the moisture content decreases, whether the moisture content considered is the initial moisture of seed cotton on the wagon or that measured at some point during the drying process. Also, during any one pass through a drier, the highest percentage of drying occurs during the first part of the exposure time.

While the seed cotton is being dried, it is necessary to keep a continually changing flow of drying air in contact with the fiber surfaces. The more turbulent the action of air and cotton, the faster drying will proceed. In the USDA-designed tower drier, turbulence is the result of the many directional reversals of the seed cotton and the flow of the drying air past the cotton. In a tower drier, the air travels at a faster average speed than does the seed cotton.

The amount of moisture removed by a constant volume-temperature-exposure drier depends on the initial moisture content of the cotton. More moisture will be removed from wet cotton and less from dry cotton. Workers at the Southeastern Cotton Ginning Research Laboratory at Clemson, S.C., used one 24-shelf tower drier with a constant inlet drying air temperature of 180° F. to dry seed cottons ranging in moisture content from 7.5 to 15 percent. They found that 25 percent of the lint was below 5 percent in lint-moisture content, 67 percent was from 5 to 7 percent, and the remaining 8 percent was above 7 percent.

Moisture contents (wet basis) of cottons that received identical seed cotton drying and that were

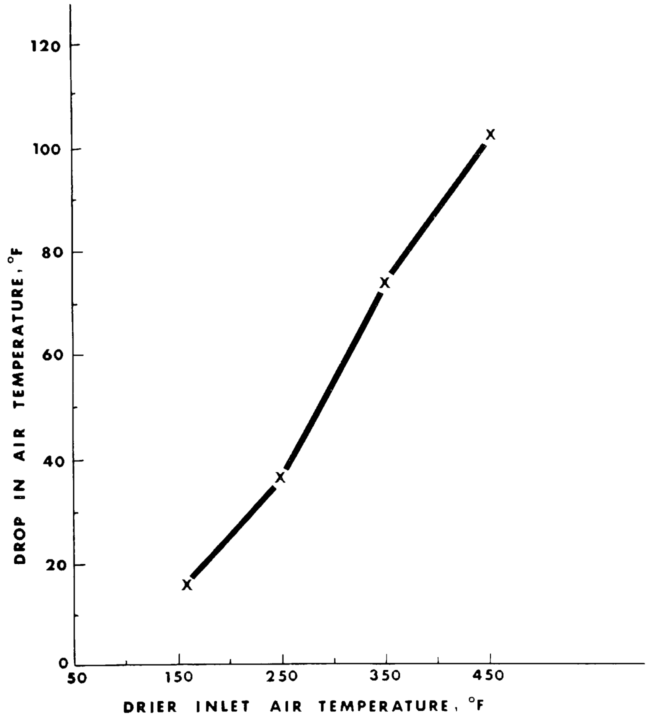


Figure 12.—**Drop in air temperature between the inlet and the outlet of 18-shelf tower drier, with 12-inch shelf spacing and air flow of 5,000 c.f.m. without cotton. Air temperature 60° to 80° F.**

passed through an 18-shelf tower drier with a constant inlet drying air temperature of 250° F. were as follows:

Seed cotton		Lint slide
Wagon	Feeder apron	
Percent	*Percent*	*Percent*
15. 4	13. 2	7. 2
13. 8	11. 0	6. 4
12. 2	9. 4	5. 2
11. 5	9. 6	5. 5
10. 4	8. 8	5. 7
9. 8	8. 0	4. 9
9. 3	7. 9	4. 0
8. 2	6. 9	3. 6
6. 9	6. 2	4. 1
6. 8	5. 3	3. 4
6. 4	5. 6	3. 7
5. 1	4. 2	3. 2
[1] 10. 3	[1] 9. 0	[1] 4. 0

[1] Average.

Seed cotton moistures measured on the wagon had a 10-percent range, whereas the dried lint had only a 4-percent range. As the moisture content of the seed cotton on the wagon decreased, the amount of drying decreased.

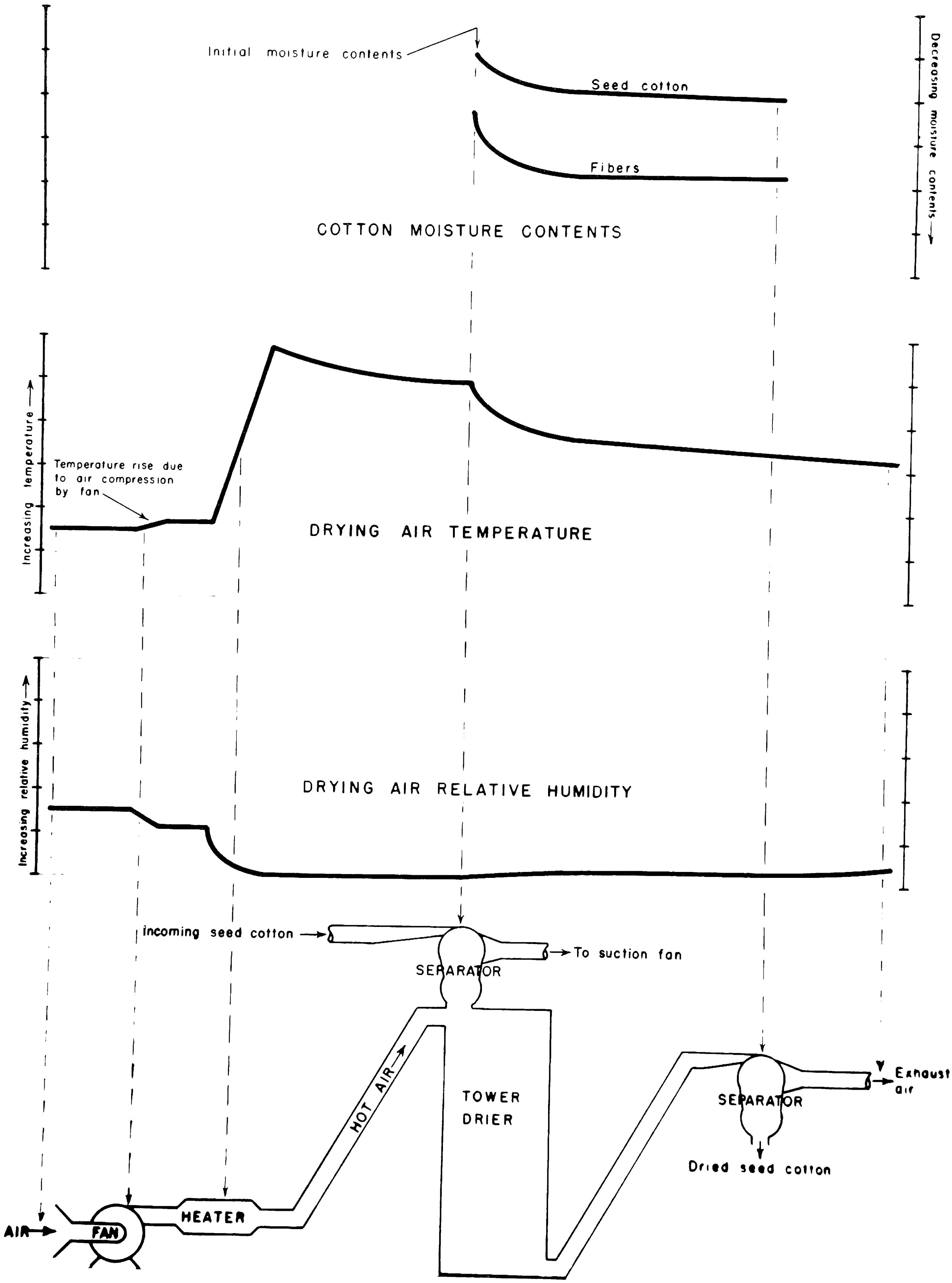


Figure 13.—Typical operation of a single stage of seed cotton drying.

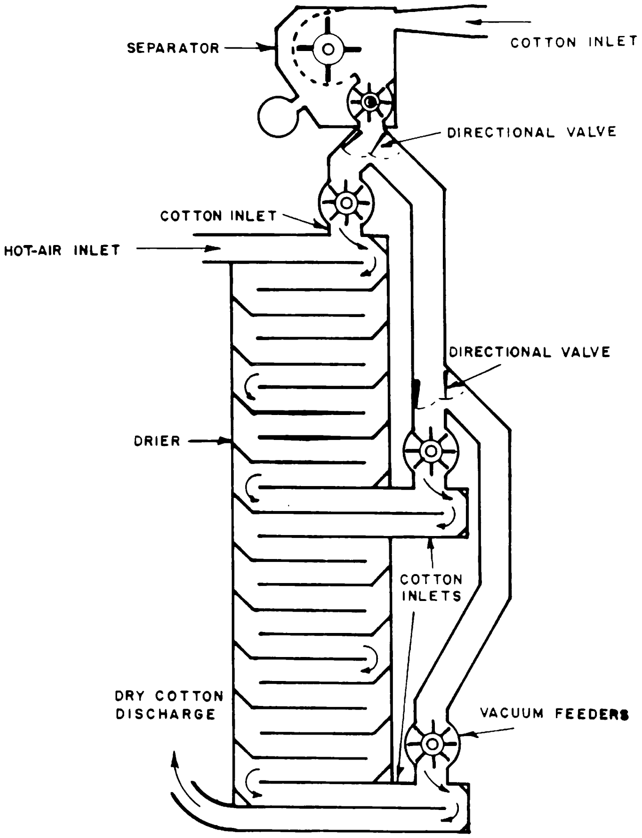


***Figure 14.*—USDA-developed multipath seed cotton drier for controlled exposure drying.**

The moisture content of cottons within the same load brought to the gin often varies greatly, and the drying process tends to level out these variations.

The ginner cannot control the moisture content of the cotton coming to the gin yard, but he can measure the moisture content of each load on the yard by using one of the commercially available portable moisture meters. He can then mark the conveyance so that the drying system can be best adjusted to the load, and so that loads having similar moisture contents can be grouped in line for ginning. He can also see that seed cotton stored on the yard awaiting ginning is protected from the weather. The ginner should recommend to his growers that they follow good harvesting practices, particularly with regard to delaying their harvest until the cotton has dried out after inclement or very humid weather.

Drying can be done by gin driers without using artificial heat when the relative humidity of the ambient air is low, as it is during dry spells or in dry areas. If the drying air is pumped into the drier by a fan (push system), the temperature will rise several degrees because of the compression of the air by the fan. This temperature rise will lower the relative humidity of the air and will increase the drying potential of the air. Table 3 shows the amounts of drying obtained by passing seed cottons through a single-tower drier, using ambient air and heated air on relatively dry cottons.

The effect of the relative humidity of the ambient air in the gin room on the moisture content of lint and seed cotton being ginned and cleaned is shown by the data in table 4. There was no significant change in the lint moisture when the ambient relative humidity was 70 percent. But when the relative humidity was 30 percent, the lint continued to lose moisture as it progressed through the system. Each time cotton enters a new conveying air stream, moisture is increased or lost unless the fibers are near the equilibrium moisture content of the air.

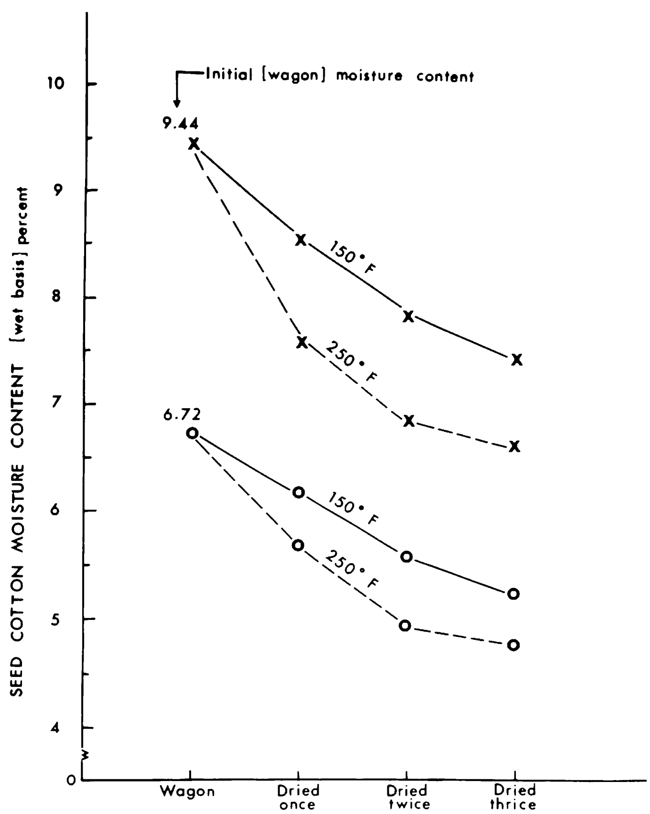


***Figure 15.*—Seed cotton moisture contents measured on the wagon and after being dried once, twice, and three times in an 18-shelf tower drier using two drying air temperatures and cottons of two different initial moisture contents.**

TABLE 3.—*Amounts of drying obtained by one pass through an 18-floor tower drier using ambient air (heater off) and using heated air*

MACHINE-PICKED BEFORE FROST

Air conditions: Ambient: Temperature (°F.)	Air conditions: Ambient: Relative humidity	Air conditions: Inlet to tower drier	Moisture contents, wet basis: Seed cotton, wagon	Moisture contents, wet basis: Lint: Roller ginned from wagon	Moisture contents, wet basis: Lint: Lint slide	Initial lint moisture removed [1]
	Percent	*°F.*	*Percent*	*Percent*	*Percent*	*Percent*
82	27	[2] 91	10.0	8.05	7.22	12
83	26	150	10.0	8.05	6.34	21
MACHINE-PICKED AFTER FROST						
60	25	[2] 71	6.5	5.43	5.20	5
67	21	143	6.5	5.43	4.53	17

[1] Calculated, using moisture content, dry basis.
[2] Ambient air entering tower drier is approximately 10° higher than room air due to fan rise.

TABLE 4.—*Effect of relative humidity of ambient air on lint moisture content during ginning and lint cleaning*

Ambient air condition: Temperature (°F.)	Ambient air condition: Relative humidity	Moisture content, wet basis: Seed cotton [1]: Wagon	Moisture content, wet basis: Seed cotton [1]: Feeder outlet	Moisture content, wet basis: Lint: Entering first lint cleaner	Moisture content, wet basis: Lint: Entering second lint cleaner	Moisture content, wet basis: Lint: Lint slide
	Percent	*Percent*	*Percent*	*Percent*	*Percent*	*Percent*
75	70	17.6	13.6	8.5	8.5	8.8
75	30	17.7	12.4	7.4	7.2	6.7

[1] Both seed cottons were dried by one pass through an 18-shelf tower drier using an inlet drying air temperature of 250° F.

Effect of Drying on Quality

The proper use of driers on damp cotton benefits the producer, ginner, and spinner in several ways. Driers condition the seed cotton for smoother and more continuous operation of the gin plant by removing excess moisture and by fluffing the partly opened locks. The dried cotton gives up more of its foreign matter, and the ginned lint is smoother. Thus the possibility of grade reduction due to rough preparation is lessened, and the spinner is provided with raw material of optimum quality.

Seed cotton cleaning efficiency increases with increased gin drying. However, a number of research reports indicate that excessive drying at gins causes quality deterioration. The reason for this deterioration has not been firmly established. It may be due to the drying air temperature, the amount of moisture removed, the drying to too low a fiber moisture content, or a combination of these reasons. But there are sufficient data to show definite trends toward lower quality when excessive drying is used.

An effort to improve grade may result in overdried cotton. The weight losses that result from drying below the 5- to 7-percent moisture level cost the producer money, since the grade improvement is seldom sufficient to offset the reduction in bale weight; the extra fuel required costs the ginner money; and overdrying substantially reduces the use value of the cotton for the spinner.

The effects of excessive drying on cottons receiving two ginning treatments are shown by the measurements in table 5. Artificial drying (tower drier three times with 350° F. inlet air) was used on one cotton, and ambient air in the drier was used on the other. An item-by-item comparison shows in nearly every instance a decrease in quality. Every fiber length measurement shows a shortening caused by drying. This shortening is thought to be primarily from fiber breakage, as indicated by the increase in fibers one-half inch or shorter.

The color measurement "plus b" refers to yellowness of the lint as opposed to blueness or grayness. Yellowness is more desirable if it occurs naturally. Small increases in yellowness caused by drying are shown, but they are not believed to have any importance in relation to ginning practices. These data are used only as an example; different cottons will react differently. But, in general, quality deterioration can be expected when cotton is dried more than it needs to be to obtain smooth ginning. Some effects of ginning cotton too high or too low in fiber moisture content are as follows:

Cotton with fiber moisture content above 7 percent	*Cotton artificially dried to fiber moisture content below 5 percent*
Rough preparation	Lower turnout
Low to fair grades	Slower ginning
Chokages in ginning probable	Difficult pressing
	Static possible
	Shorter staple
	Decreased fiber quality

TABLE 5.—*Effects of two ginning treatments on measurements of cotton grown in the Southwest under irrigation and harvested early in the season and late in the season*

Measurement	Harvest and ginning treatment [1]			
	Early season hand picked		Late season hand picked	
	No heat	Heat	No heat	Heat
Ginning capacity, *lbs. lint per saw per hr*	8.3	7.5	7.5	6.3
Lint turnout, *percent*	32.3	31.6	31.1	29.9
Lint moisture (wet basis), *percent*	4.55	2.13	4.39	1.65
Trash in lint, *percent*	1.59	1.25	3.71	2.87
Grade designation [2]	GM	GM	M	M
Staple length, ¹⁄₃₂ *inch*	36.2	35.3	36.7	36.0
Fibrograph, upper half mean length, *inch*	1.22	1.19	1.17	1.14
Fibrograph, *uniformity ratio*	81	78	79	77
Fiber strength (⅛-in. spacer), *Pressley index*	123	120	114	113
Array, upper quartile length, *inch*	1.37	1.36	1.32	1.31
Array, mean length, *inch*	1.15	1.11	1.08	1.05
Array, *coefficient of variation*	28	32	31	33
Array, fiber 1 inch and longer, *percent*	76.9	72.1	69.8	65.9
Array, fiber ½ inch and shorter, *percent*	6.5	8.7	8.4	10.8
Color reflectance, *Rd* [3]	80.6	81.3	78.7	77.7
Color yellowness, *plus b*	8.4	8.8	8.0	8.7
Fiber neps, *No. per 100 square inches*	16	18	21	18
Card web neps, *No. per 100 square inches*	19	13	22	16
Yarn strength, 22's, *pounds*	160.8	153.7	161.2	157.2
Yarn strength, 60's, *pounds*	47.7	44.5	49.0	45.8
Yarn, *break factor*	3,200	2,832	3,243	3,103
Yarn appearance, 22's, *index* [4]	B	C+	C+	B
Yarn appearance, 60's *index*	C+	C+	C	C+
Picker, card, and comber waste, *pounds*	16.9	18.2	19.8	20.9

[1] "No heat" treatments included tower drier three times with ambient air. "Heat" included tower drier three times with 350° F. inlet air. All treatments were replicated three times and included a maximum of cleaning with one saw-type lint cleaner.

[2] GM = Good Middling; M = Middling.

[3] Rd = Percent reflectance.

[4] B = Good; C+ = Average; C = Fair.

Driers

Seed cotton drying, as now practiced, ranges from the use of one drier to the use of several of various designs placed at intervals to be used in combinations with other equipment employed in the cleaning process. Also, the practice of introducing heated air into some of the cleaning devices themselves is widespread.

Seed cotton drying is a continuous process, as contrasted to batch drying. Driers may be either parallel flow or counterflow; however, the parallel-flow type predominates in the industry. The first widely used driers were of the USDA-designed tower drier type patented by C. A. Bennett in 1932. This type has remained in wide use and is illustrated in figure 16.

Figures 17 through 23 show typical driers commercially available for gin use. All except the one shown in figure 20 are parallel-flow driers. The seed cotton may be moved through a drier by the momentum of the drying air, by gravity, by mechanical means, or by a combination of these.

Cleaning and extracting apparatus is incorporated in some driers, such as those shown in figures 17 through 20. Some driers, such as the reel

Figure 16.—**Cross section of a typical tower (shelf) type seed cotton drier showing flow path of cotton.**

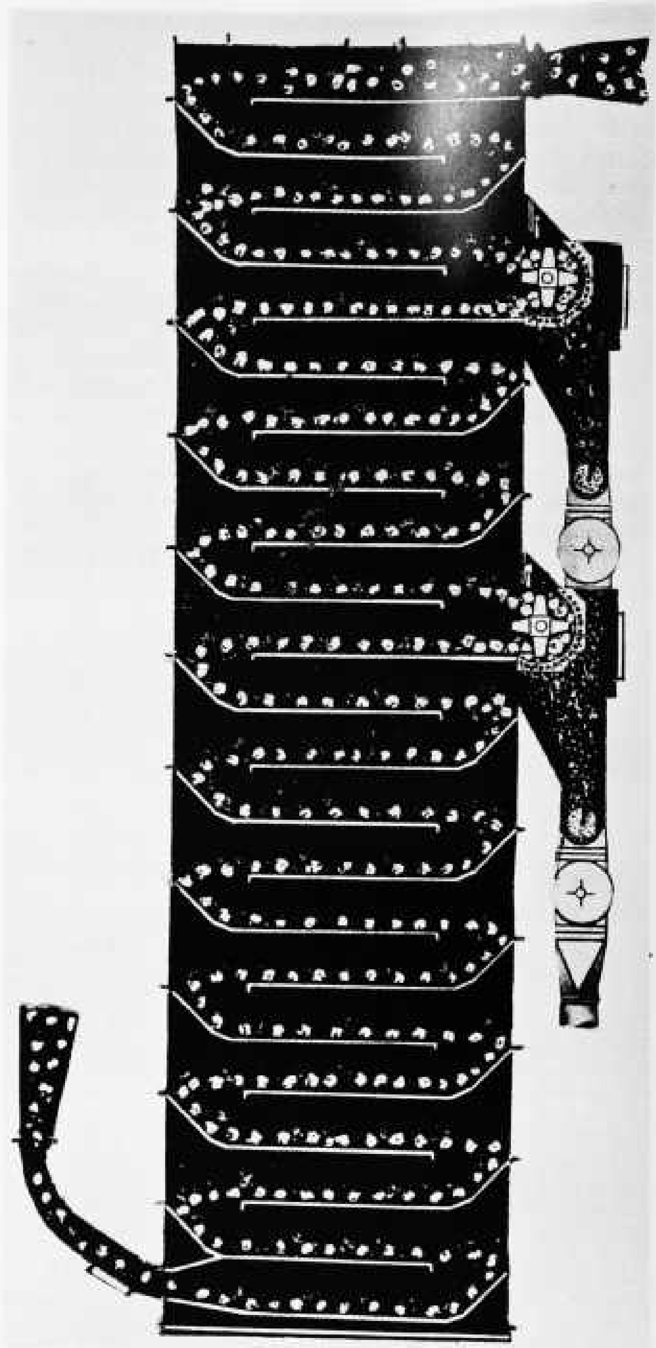


Figure 17.—**Cross section of a tower drier with auxiliary seed cotton cleaning apparatus.**

type shown in figure 22, are inherently capable of cleaning the cotton. In some instances, the cleaning apparatus is modified for drying, such as the extractor feeder shown in figure 23, which uses hot air.

The drier is generally used early in the process to condition the cotton for cleaning, extracting, and ginning. Two arrangements of hot-air fan and tower driers are shown in figures 24 and 25. Figure 24 illustrates a "push" system where the hot air is blown into the drier. Figure 25 illustrates a "pull" system where the hot air is pulled or sucked into the drier. Some gins use a combination "push-pull" system.

Commercial driers will perform satisfactorily if properly sized, installed, and maintained. Manufacturers' recommendations and routine maintenance procedures should be followed to assure good operation at minimum expense.

Every drier should have a thermometer plainly visible to the ginner to indicate the temperature of the drying air. The temperature of the air entering the drier should be measured immediately before the hot air and incoming seed cotton meet.

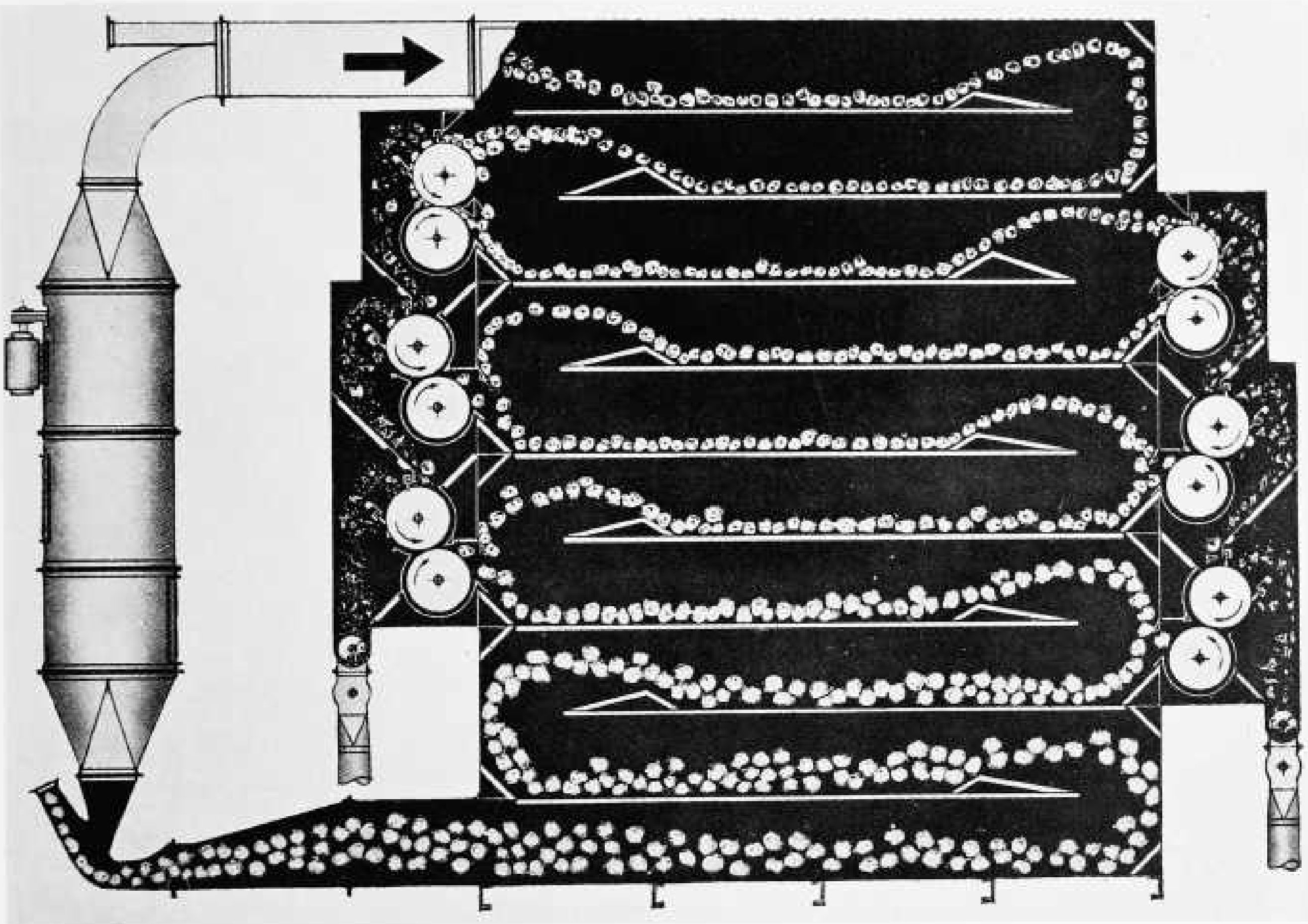


Figure 18.—Cross section of a shelf-type, large-volume seed cotton drier incorporating cleaning apparatus.

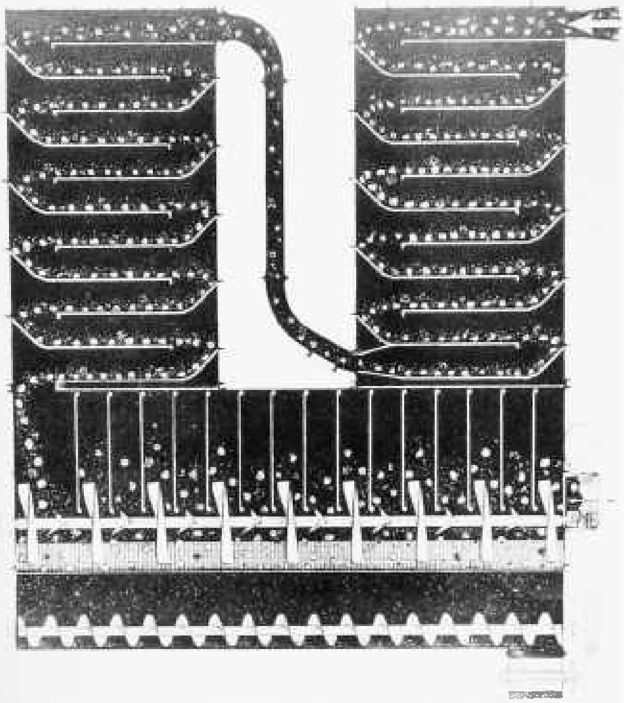


Figure 19.—Cross section of combination tower drier units and drier-cleaner.

HEATERS, VAPORIZERS, AND HEAT CONTROLS

By A. C. Griffin, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

Heaters for gin drying systems use natural gas, propane, butane, propane-butane mixtures, or oil for fuel. Natural gas and oil are used directly, but propanes and butanes are delivered as liquefied gases and must be vaporized before delivery to the heater. Nominal heat content for the more prominent fuels are:

Natural gas	1,120 B.t.u./cu. ft.
Propane	91,300 B.t.u./gal.
Butane	103,000 B.t.u./gal.
Propane-butane mixtures	100,000 B.t.u./gal.

Gins using liquefied petroleum gases (LPG) require a vaporizer to change these gases from the liquid state to the gaseous state rapidly and in large quantity.

Probably 95 percent of the U.S. cotton gins using LPG use the same type of vaporizer. The vaporizer must be located within 30 feet of the storage tank valves and at least 5 feet from the valves. Two flow lines connect the vaporizer to the tank. All lines must be sufficiently large in diameter. Using too small a pipe for the vapor line, for the liquid line, or for the gas service line may cause the system to operate unsatisfactorily. Pipe and tube size requirements are as follows:

Vapor line (from top of tank to top of vaporizer):

- If less than 15 feet long, use ¾-inch minimum pipe.
- If more than 15 feet long, use 1-inch minimum pipe.
- If more than 30 feet long, consult manufacturer for proper pipe size.

Figure 20.—Cross section of a vertical counterflow-type seed cotton drier incorporating seed cotton cleaning apparatus.

LIQUID LINE (from bottom of tank to bottom of vaporizer):

If less than 15 feet long, use ½-inch minimum copper tube.

If more than 15 feet long, use ⅝-inch minimum copper tube.

If more than 30 feet long, consult manufacturer for proper tube size.

GAS SERVICE LINE (minimum pipe diameter (inches) by service requirement):

For pressures above 16 ounces:

If less than 15 feet long, use ¾ inch.

If 15 to 50 feet long, use 1 inch.

If 50 to 100 feet long, use 2 inches.

For pressures below 16 ounces:

If less than 15 feet long, use 2 inches.

If 15 to 50 feet long, use 2 inches.

If 50 to 100 feet long, use 3 inches.

All lines should be buried at least 24 inches in the ground, or otherwise protected from cold and other possible damage.

The vaporizer uses a flame to vaporize or dry the LPG, which is then delivered through a high-pressure regulator to the service line to the gin. As the gas service line enters the gin, a second pressure regulator reduces the pressure to that required by the heater.

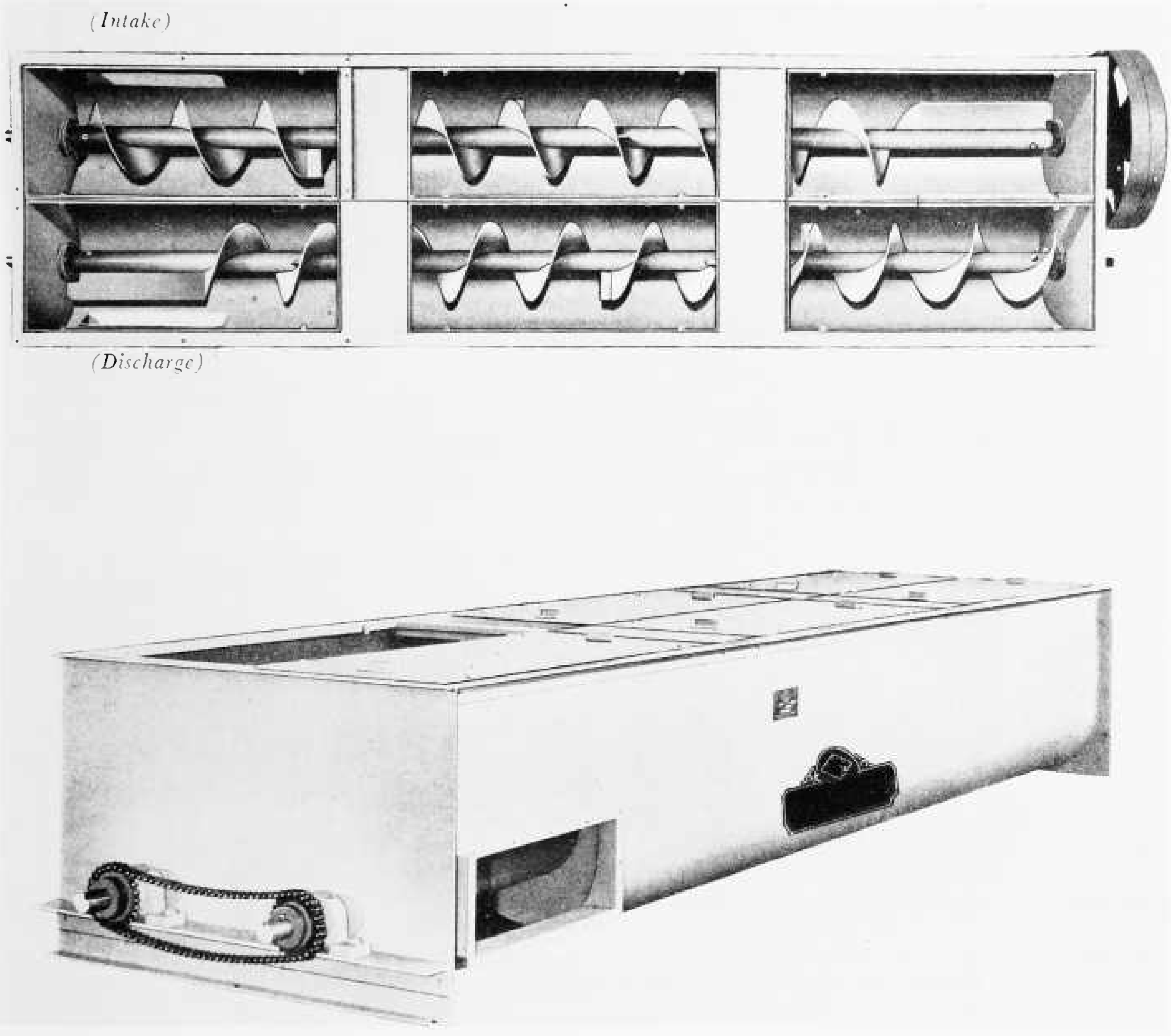


Figure 21.—Top view (with covers off) and oblique view of conveyor-distributor or trough-type drier.

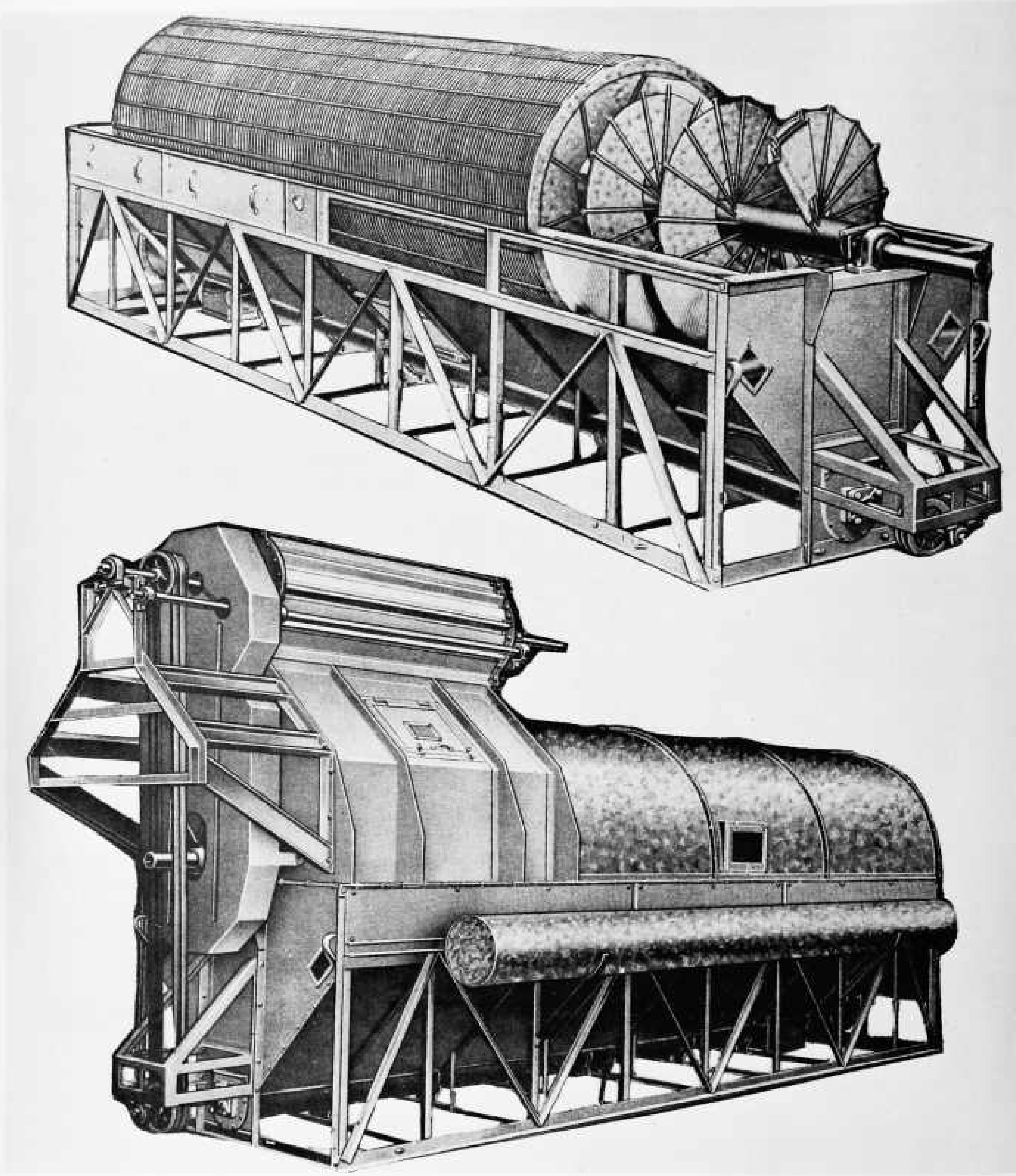


Figure 22.—Reel-type seed cotton drier. Top view with cover and vacuum feeder removed to show interior. Bottom view of complete unit showing hot-air manifold pipe from which hot air blows into main drier the length of the reel.

Gin heaters cannot use LPG in the liquid state. When operation of gin heaters using LPG is unsatisfactory, look for (1) restrictions or stuck valves in the vaporizer and flow lines, (2) pilot-light failure in the vaporizer, and (3) recondensation of butane in exposed gas service line (butane condenses at about 30° F. at atmospheric pressure).

Heater capacity is determined principally by the volume of air to be heated and is related to the ginning capacity of the plant. Temperature, moisture content of cotton, and drying system heat losses are important considerations.

Figure 26 shows the temperature effect of adding heat at various rates to several volumes of air. Since air volume is the product of pipe cross section times air velocity, this graph may be used to calculate required pipe or fan changes when a larger or smaller heater is installed. Increases in air volume are often required when larger heaters are installed in older gin plants, if the full capacity of the new heater is to be used.

As heat is added to ambient air, the relative humidity of the air decreases. As the latter decreases, the moisture-absorbing capability increases. At higher temperatures, the cotton heats faster, and evaporation (drying) is more rapid. (See Drying, p. 11, for danger of elevated temperatures.)

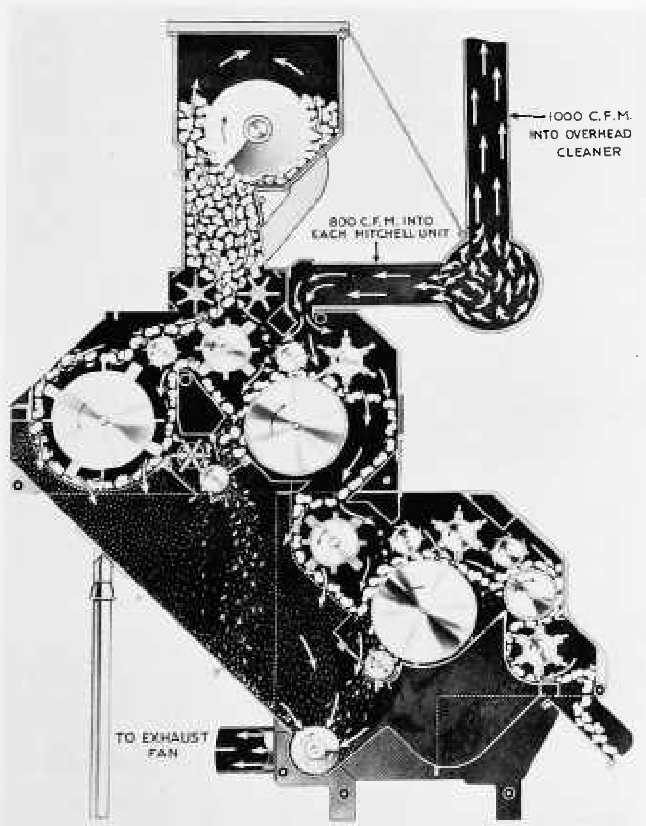


***Figure 23.*—Cross section of extractor-feeder using hot air for seed cotton drying.**

High-capacity, gin-drying-system heaters require both manual and automatic controls for temperature regulation and safe operation. Fire and safety codes require that the main gas valve be interlocked with other components of the gin system, so that fuel will not be fed to the burner under any of the following conditions:

(1) When electric power fails.
(2) When an insufficient volume of air moves through the heater.
(3) When the pilot flame fails.
(4) When components in the safety circuit fail.

Manual Control

Many gins still operate drying-system burners without automatic temperature control. A dial thermometer is the usual temperature indicator by which the ginner adjusts the gas flow into the heater. The thermometer pressure bulb is usually located near the drying-system exhaust. The temperature at the point where the cotton enters the hot air may be considerably higher than it is at the measuring point (fig. 27). Manual control provides a constant, level heat input and can be changed only by changing the gas valve setting.

Automatic Control

On-off control.—The "on-off" or "high-low" controllers are the most common temperature regulators. In its simplest form, a controller-thermometer located in the lower portion of the drier activates a simple electric switch that opens or closes the main gas valve through a solenoid or by means of slower acting motor devices. These devices maintain the temperature at the control point satisfactorily, but the temperature at the cotton hot-air mixing point may fluctuate. Figure 28 shows the temperature pattern of a typical gin drying system produced by this type of controller. This controller functions regardless of the presence of cotton in the system.

The temperature at the control point remains fairly stable, but on cool days and in gins with long pipe runs the mixing point temperature may be from 150° to 200° higher than the control-point temperature. This situation contributes to overdrying and is responsible for much cotton scorching and for many gin fires, especially when dry cotton is ginned after damp cotton is ginned.

Sometimes the burner is equipped with two gas inputs or with valve travel limit control to minimize the spread between high and low temperatures.

Modulating control.—Principal manufacturers of gin machinery now sell controllers that use an

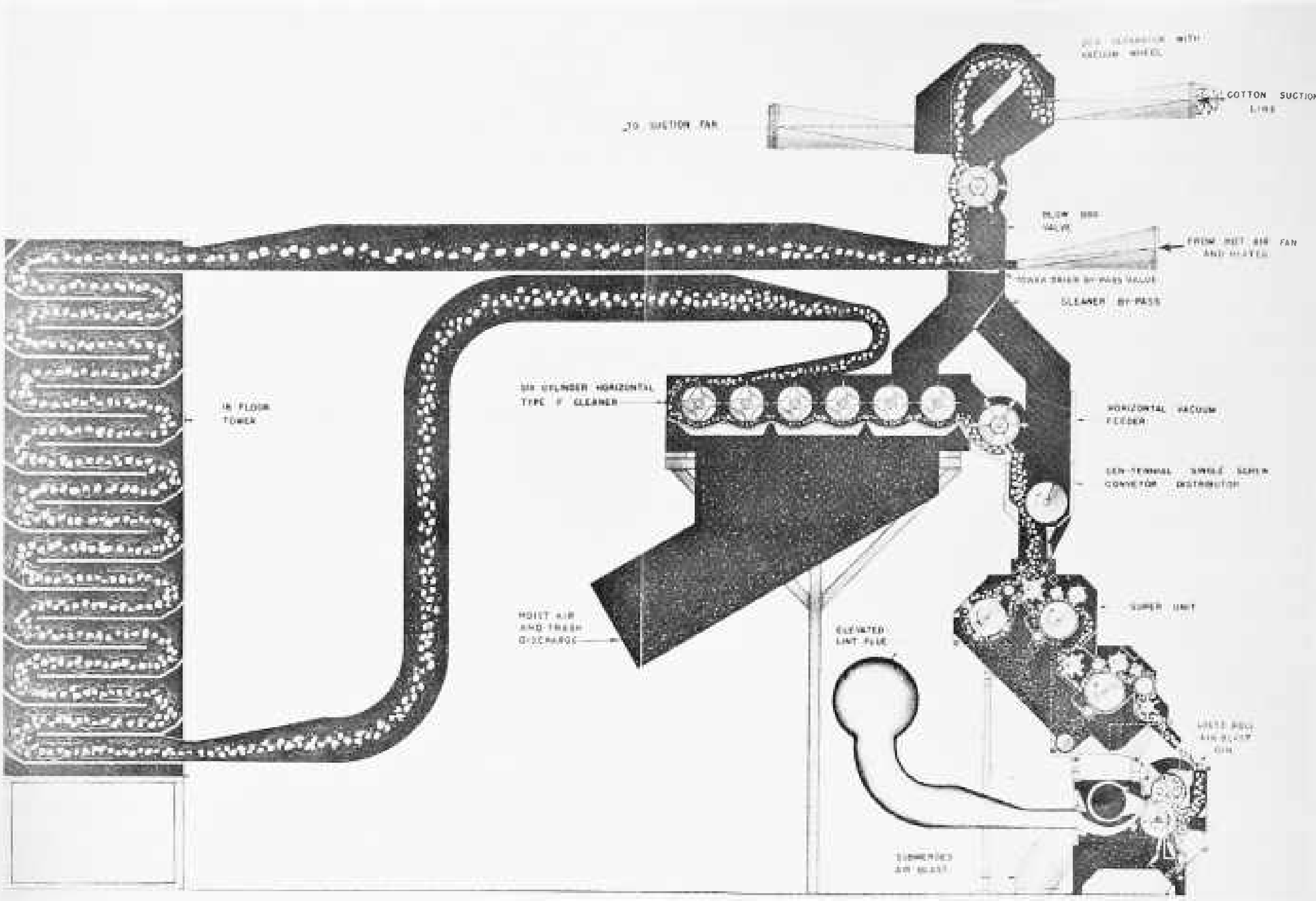


Figure 24.—Cross section of a blow-through or push-system tower drier installation with drier discharging directly into a seed cotton cleaner.

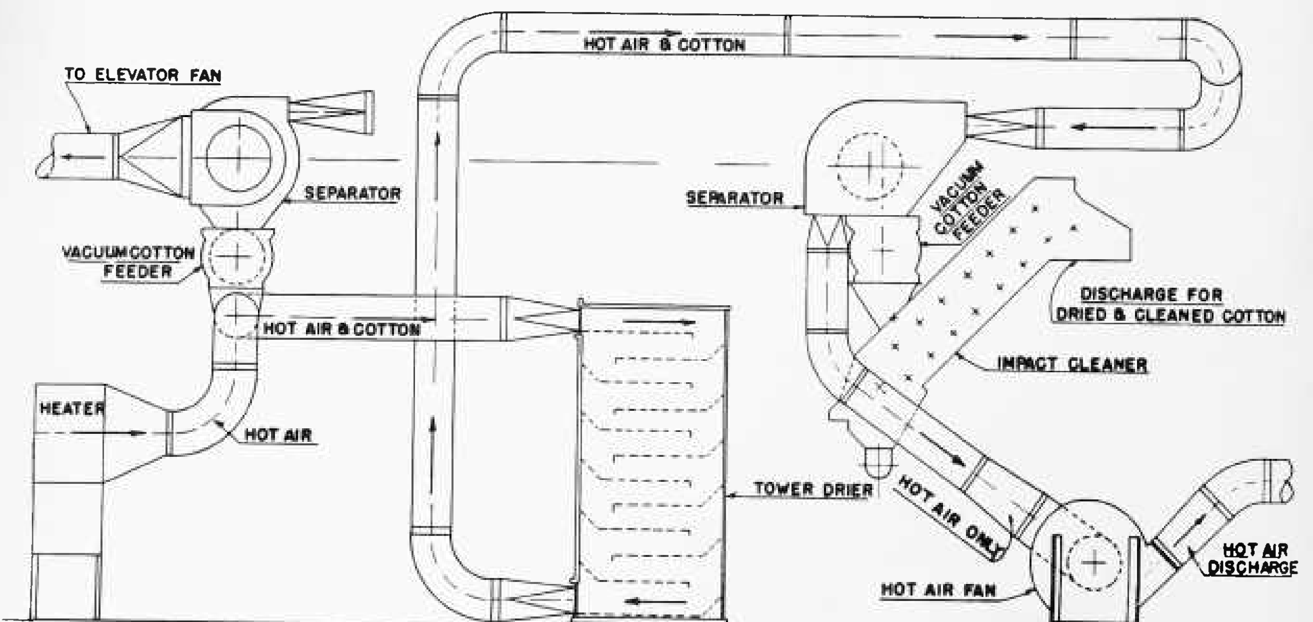


Figure 25.—Line drawing of a pull-through (hot-air fan on outlet side of drying system) tower drier installation with drier discharging into a seed cotton separator.

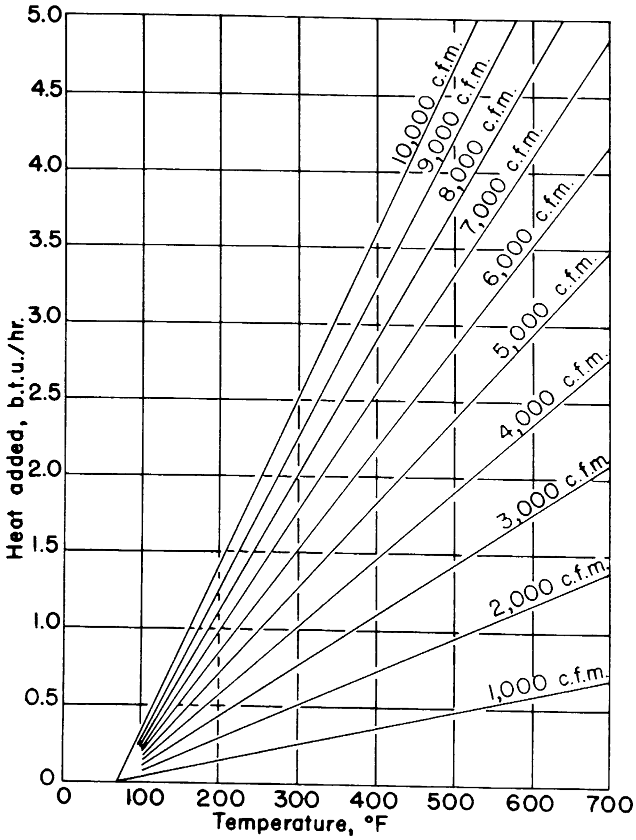


Figure 26.—**Temperature effect of adding heat to air moving through a gin drying system.**

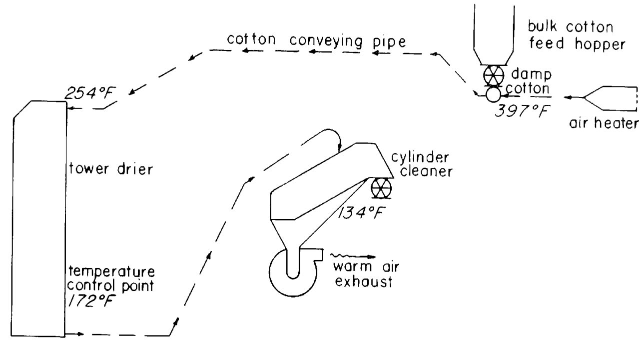


Figure 27.—**Actual temperature measured at four locations in gin drying system.**

electronic thermometer instead of a pressure bulb. The electronic thermometer feeds a control circuit that in turn regulates the position of the gas valve motor. The sensing element can be located at the cotton-air mixing point and can thus exercise close control at that point. A temperature gradient still exists through the drying system, but the input temperature is now stable. An electronic fiber moisture detector regulates the ginning temperature based on drying need rather than having a fixed temperature set high enough to dry the wettest cotton anticipated. Because of differences in drying system characteristics, temperature based on drying need must be regulated individually for each gin.

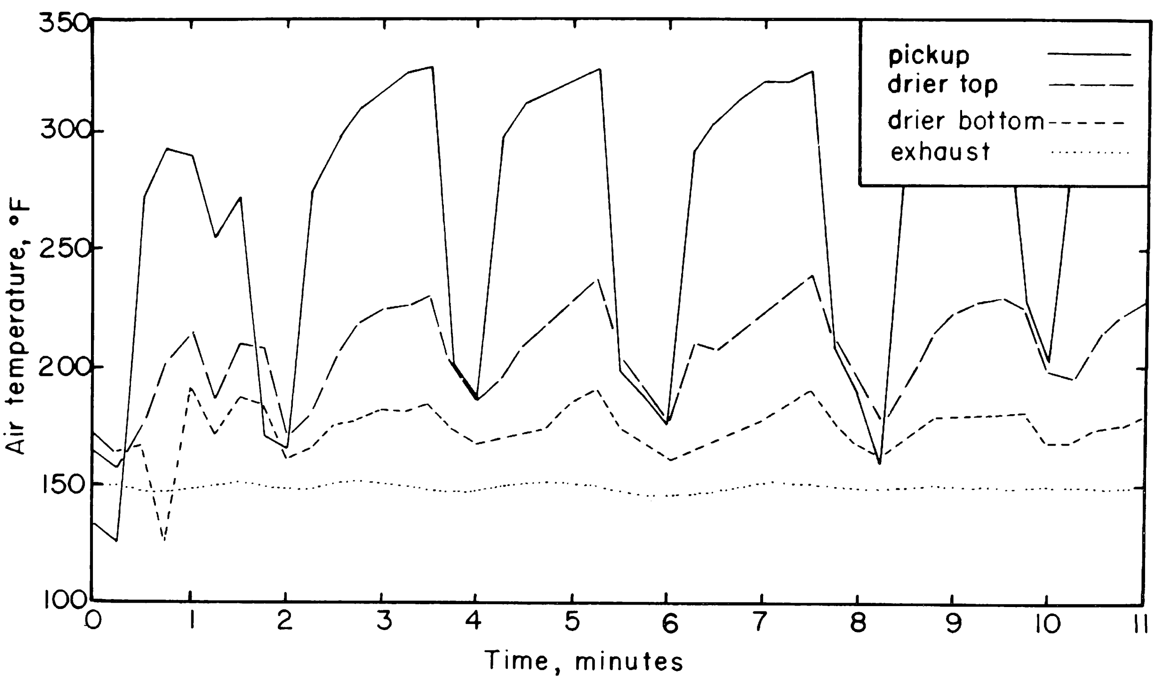


Figure 28.—**Effect of "on-off" type of heater control on temperatures at four locations in drying system. Note wide fluctuations at cotton pickup point, although control point at exhaust remains almost unchanged.**

CLEANING AND EXTRACTING

By C. S. Shaw and G. N. Franks, *cotton technologist and agricultural engineer, respectively, Agricultural Engineering Research Division, Agricultural Research Service*

The practice of cleaning cotton at the gin has developed gradually through the years to meet the demands that have arisen as a result of rougher harvesting methods (*10*). Carefully hand-picked cotton did not require much cleaning.

In 1931 the practicability of a seed cotton drier for use at gins was demonstrated. Because dry cotton can be cleaned much more readily than damp cotton, this drier has greatly expanded the use of cleaning machinery at the gin.

The types and amounts of cleaning machinery used vary widely throughout the Cotton Belt and are closely related to the kinds of cotton grown and the harvesting methods used. Before 1900, the cleaning equipment represented no more than 5 percent of the total machinery investment at gins. In the gin plant of 1962, designed for handling roughly harvested cotton, the cleaning and drying equipment represented approximately 70 percent of the machinery investment.

Cleaners are used mainly for removing fine trash and leaf. They may be obtained in a variety of forms, such as those having revolving spiked cylinders with screen (fig. 29), grid bars (fig. 30), or revolving screen (figs. 31 and 32). In some areas, reel type cleaner-driers are used to provide additional cleaning (fig. 33).

Airline Cleaners

In general, airline cleaners (figs. 34 and 35) are of the spiked cylinder type and permit only a horizontal flow of the seed cotton from the inlet to the outlet of the machine.

Airline cleaners permit both air and seed cotton to pass entirely through the cleaner. In this respect they differ from gravity cleaners. Airline cleaners are principally employed in pneumatic systems. They are popular in the High Plains of Texas and in western Oklahoma as an effective means for removing sand from cotton and for breaking the bolls before cleaning.

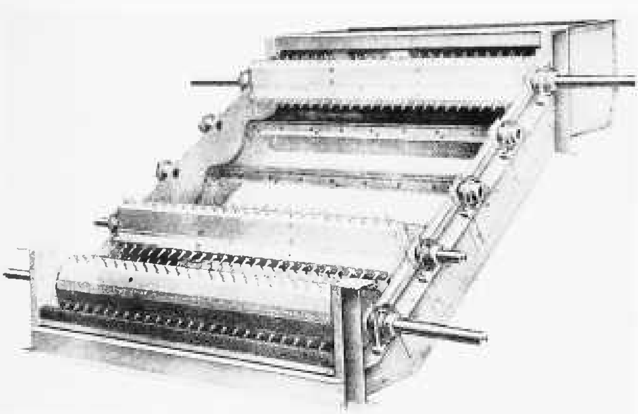


Figure 29.—**Inclined screen cleaner.**

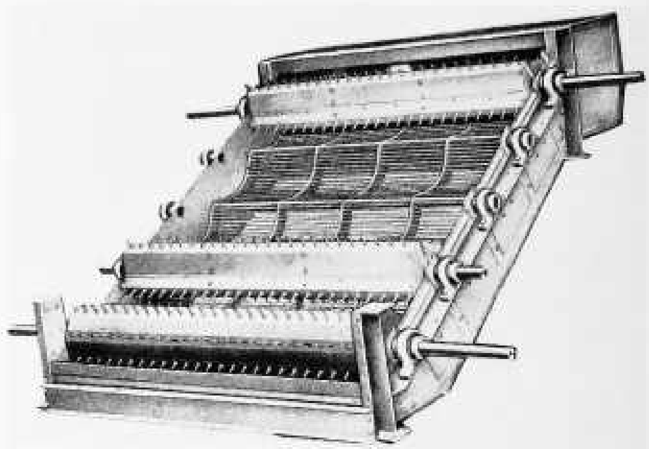


Figure 30.—**Inclined cylinder cleaner equipped with grid-rod screen.**

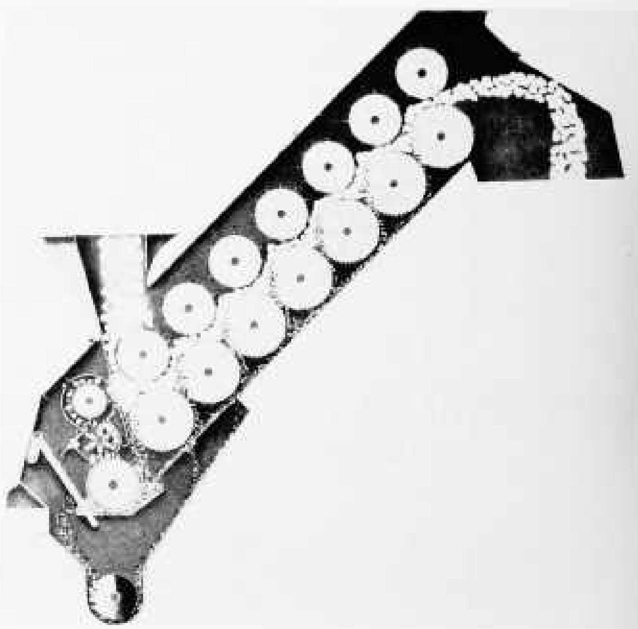


Figure 31.—**Cross section showing flow of cotton through a revolving-screen cleaner.**

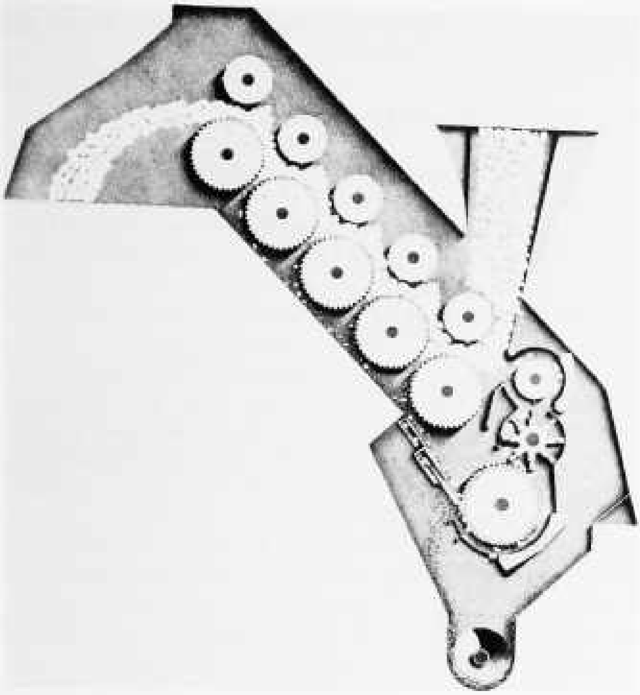


Figure 32.—**Cross sectional view of revolving-screen cleaner equipped with grid-rod reclaiming cylinders.**

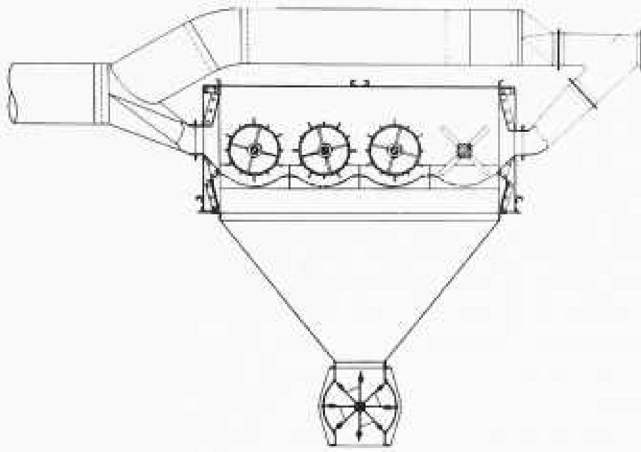


Figure 34.—**Cross section of airline cleaner.**

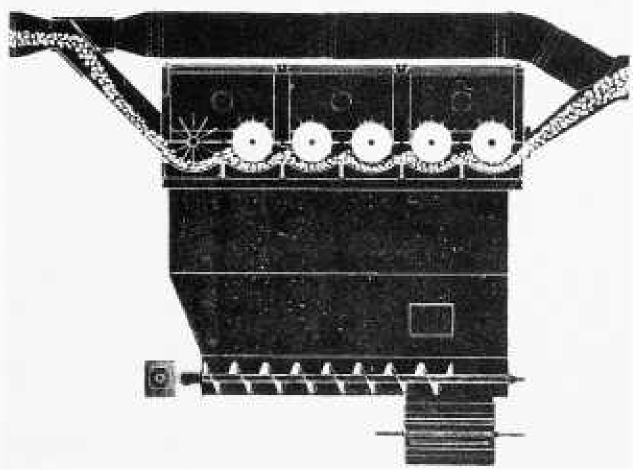


Figure 35.—**Cross section showing flow of cotton through an airline cleaner.**

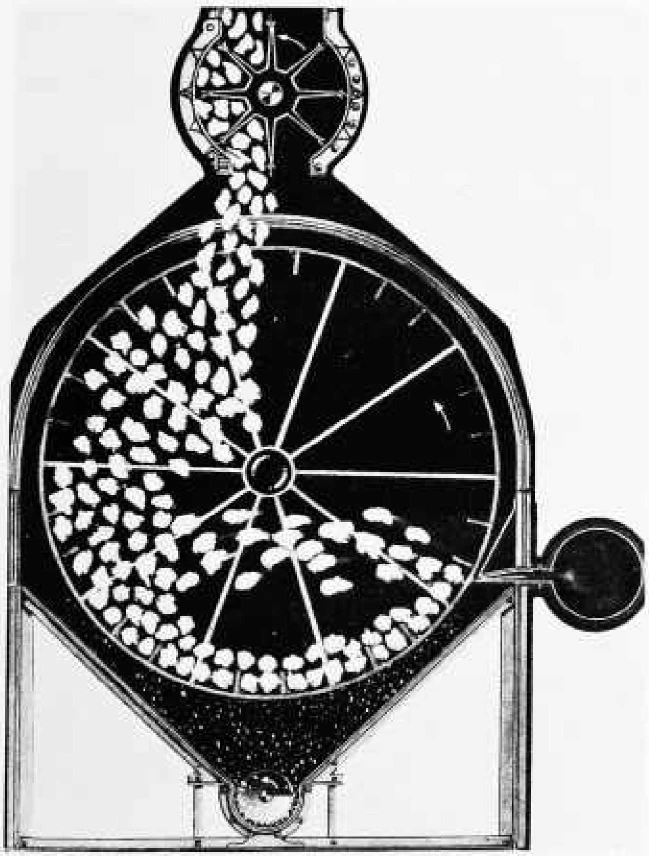


Figure 33.—**Cross section of reel-type seed cotton cleaner-drier.**

Gravity Cleaners

Gravity-type cleaners permit both inclined and horizontal flow of the cotton. Inclined-gravity cleaners are common where there is little headroom (figs. 36 and 37). The separator may be mounted at the lower end of the cleaner. Where headroom is sufficient, the separator is placed at the upper end of the cleaner with a bypass, so that the cotton may be discharged either to the cleaner or directly into the distributor.

Horizontal gravity-type cleaners, when fitted with vacuum-wheel trash discharges, may be used as airline cleaners. The cotton is conveyed pneumatically into and from the cleaner and the trash is separated through screens.

Extracting Units

Extracting units, including extractor-feeders, are more effective in removing burs, sticks, and other large foreign matter from roughly harvested cotton than are screen cleaners (figs. 38 to 41). The large extracting machines may be used in overhead positions as master extractors to serve the entire ginning battery. Small machines may be used as unit extractor-feeders to supply individual gin stands and to replace older forms of cleaning feeders.

General trends in the design and installation of cleaners and extractors are toward simplicity and compactness. For economy, cleaning and drying equipment should be selected and installed at the same time.

Stick-and-Green-Leaf Machines

The USDA stick remover (*6*) is an improved cleaning and extracting machine that removes sticks from machine-stripped cotton (fig. 42).

Cotton-ginning machinery manufacturers have made wide application of the principles used in the stick remover, which includes extractor, saw cylinders, and grid bars (figs. 43–49).

Table 6 gives some general information on capacities, width dimensions, and approximate horsepower requirements of cleaners and extractors. A good, general rule for estimating the power requirements of cylinder cleaners is to allow about one horsepower for each cylinder.

Two forms of conveying systems—mechanical and pneumatic—are common in ginning establishments. Conveyor-distributors are widely employed to transfer seed cotton to and from big-bur or master extractors; pneumatic conveying is usually preferred between driers and cleaners. With the mechanical system, the seed cotton is also fed to each bank of feeders and gin stands. Any surplus seed cotton is discharged at the overflow, from which it may be pneumatically returned to the handling system. Both systems are, therefore, suitable for use with many combinations of conditioning, cleaning, and extracting machinery.

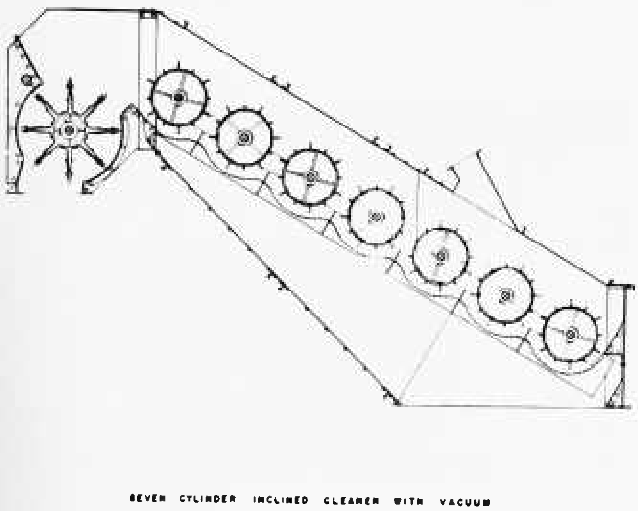


Figure 36.—Cross section of 7-cylinder inclined cleaner.

Figure 37.—Cross section showing flow of cotton through an inclined cleaner.

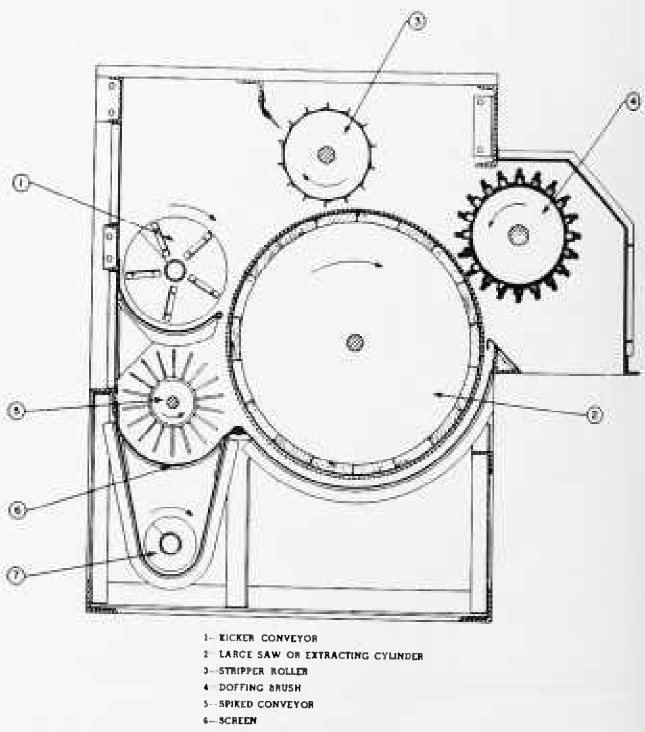


Figure 38.—Cross section drawing of a bur machine.

TABLE 6.—*Width, number of cleaning cylinders, approximate capacity, and power requirements of various types of overhead seed cotton cleaning machines used in cotton gins (models through year 1961)*

Machine	Width range	Cleaning cylinders	Other information	Approximate capacity (bales per hour)	Power requirement range
	Feet	*Number*		*Number*	*Hp.*
Unit extractors	5–12	3–12	Including extractor feeders and after cleaners.	1½–8	2–5
Master extractors	6–18	2–4	Including bur machines and stick removers.	4–20	5–20
Inclined cleaners	5–8	5–11	Including screen and grid cleaners	6–20	4–15
Airline cleaners	4–5	4–6		5–8	4–7½
Drier-cleaners	6		Excluding hot air	12	8

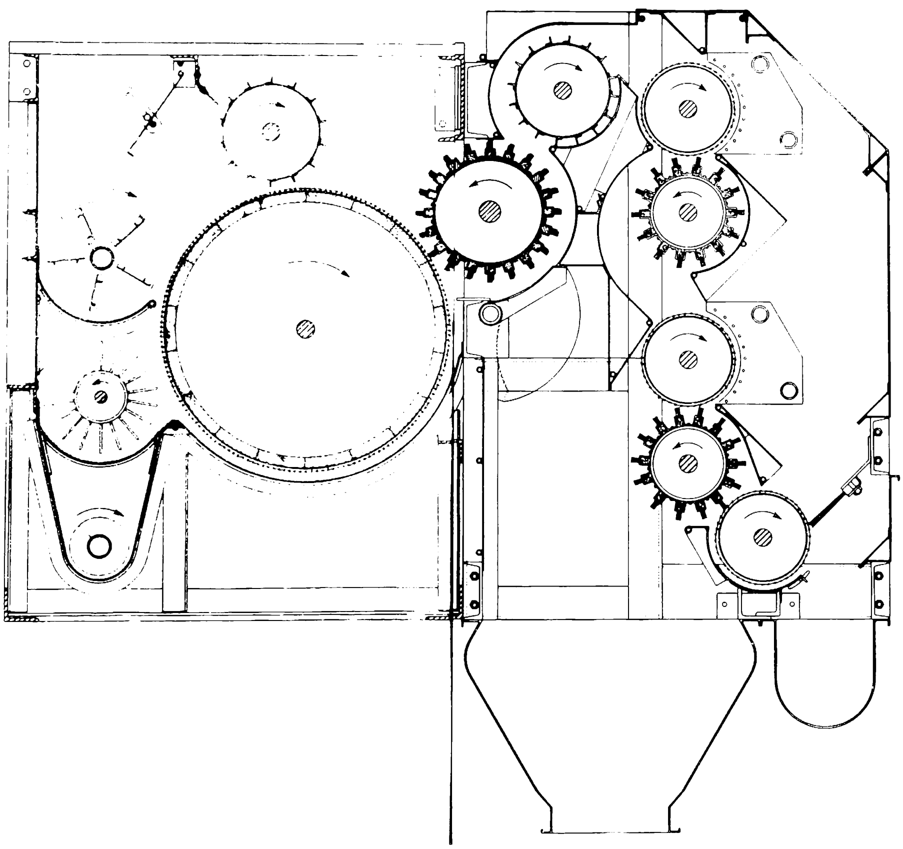


Figure 39.—**Cross section of bur machine (left) with stick remover attachment added (right).**

One method of returning this overflow of cotton to the handling system is the "live overflow," which consists of a small hopper under the discharge of the distributor. This hopper has a 10-inch pipe connected near the bottom that extends to a small separator mounted over the distributor as near the Number One stand as possible. A size 30 fan will usually supply enough suction through the separator to convey the cotton back to the distributor (fig. 50). This method of handling allows continuous return of the overflow cotton to the ginning system without the cotton again passing through the drying and cleaning system. The live overflow should be used only when there is an automatic feed control in the ginning system. It works satisfactorily when cotton overflow is kept to a minimum.

Operation and Maintenance

Cleaning and extracting machinery should be checked at regular intervals for proper bearing lubrication and for removing excessive accumulations of roped and tagged cotton or other undesirable material. Channel saws, cylinders, screens, grids, and bearings should be kept in good condition. The machinery should be operated within capacity limits and at the manufacturer's recommended speeds. Fastening bolts, latches, and housings should be checked periodically for tightness. Belts should be kept tight, pulleys firmly set, and satisfactory safety guards provided where needed.

LINT CLEANING

By V. L. Stedronsky, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

The use of lint cleaners in cotton gins is now an accepted practice, with more than 90 percent of the gins employing one or more lint cleaners. This development enables the ginner for the first time to remove foreign matter from lint cotton as a continuous process of ginning. It has contributed greatly to the success of cotton mechanization and mechanical harvesting. Lint cleaners can remove effectively and efficiently small leaf particles, motes, green leaves, and grass left in the cotton by seed cotton cleaners and extractors.

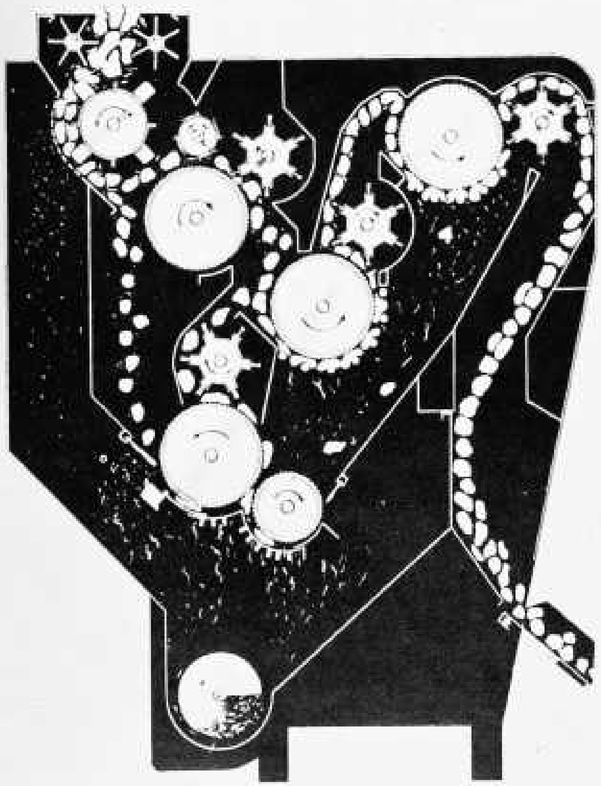


Figure 40.—Cross section showing flow of cotton through a 5-saw feeder-extractor-cleaner, having 2 saws equipped with concentric grid-rod screens.

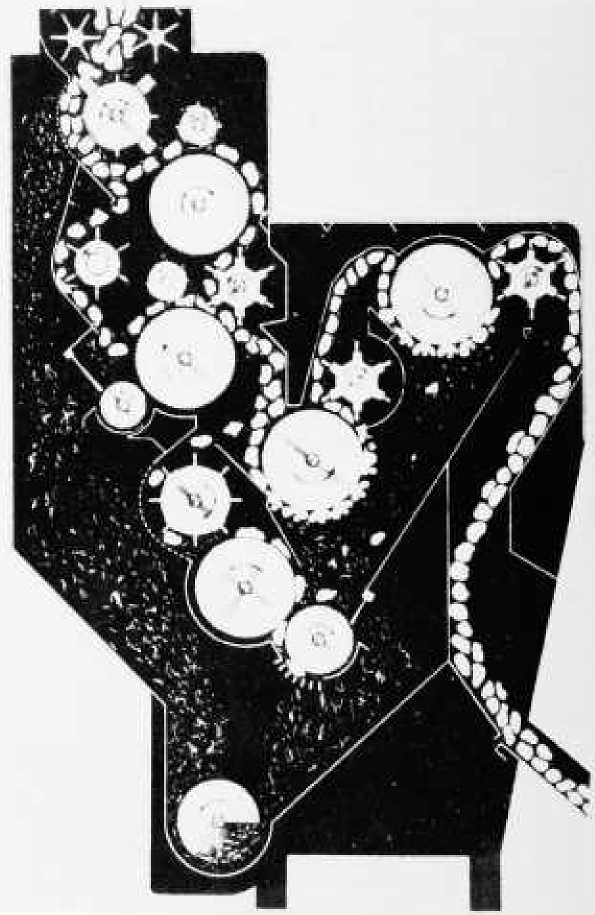


Figure 41.—Cross section showing flow of cotton through a 7-saw feeder-extractor-cleaner, having 2 saws equipped with concentric grid-rod screens.

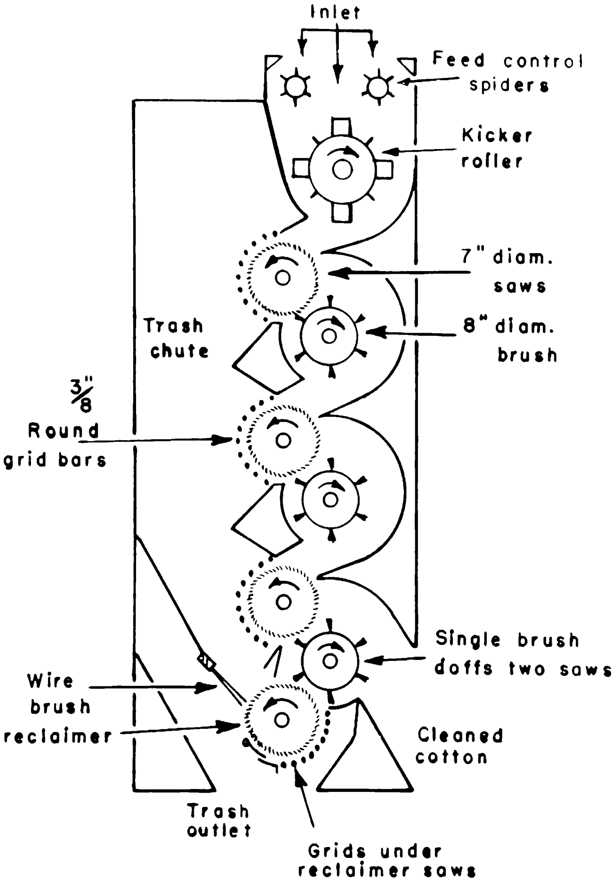


***Figure 42.*—Cross section of USDA-developed stick remover.**

Types of Lint Cleaners

In recent years, machinery manufacturers have made remarkable improvements in the design and effectiveness of lint cleaners. There are three general types: Controlled-batt saw type, flow-through saw type, and flow-through air type.

Controlled-batt saw type.—With the controlled-batt saw type lint cleaner, lint cotton is received from the gin stand or another lint cleaner unit on a condenser screen drum and formed into a batt. The batt is then fed through one or more sets of compression rollers and is finally passed between a very close-fitted feed roller and feed plate or bar into the cleaner saws (fig. 51). The evenness of the batt—its uniformity and thickness—and the manner in which it is delivered to the saw teeth are important factors in the effective operation of the lint cleaner. Each series of compression rollers revolves faster than the preceding series, and thus the batt is thinned out. The feed roller and feed bar grip the batt so that, as it is fed to the saw teeth, a combing action takes place. The saw teeth then seize the fibers and convey them to the discharge point. While the fibers are carried around by the saws, which are 14 or 16 inches in diameter, they are whipped over the keen edges of a series of grid bars. In this way, the heavier particles of foreign matter are discharged by centrifugal force. The fibers may be doffed from the saw teeth by a revolving brush, air blast, or air suction.

The condition of the batt as it is fed to the saw teeth is important and affects the operation of batt-type cleaners. Therefore, proper condenser adjustment and air balance to form a smooth, uniformly even batt are necessary. If the batt is thicker on one side than on the other, or if it is too thin or broken, the lint cleaner will not operate properly. Poor batt conditions may also cause chokages and damage the equipment. To obtain a good batt, it is necessary to have the proper air balance relation between the gin stand, the condenser, the clean air fan, and the lint flue. In most cases, axial or vane-axial fans, often referred to as clean-air fans, are employed to discharge the air from the battery condenser.

Flow-through saw type.—The cleaning action of the flow-through saw type lint cleaner is similar to that of the controlled-batt saw type, except that the lint from the gin saws is not formed into a batt (figs. 52–54). The lint is deposited on a revolving screen drum and most of the air is discharged, but a portion of it is used to convey the fibers onto the lint cleaner saw teeth. The saw teeth then convey the fibers in a thin stream over a series of grid bars at the same rate they are ginned. Thus, by the combined action of centrifugal force, gravity, and air wash, the foreign matter is removed from the lint. The fibers may be doffed by revolving brush or air blast. (These lint cleaners are used only as a unit behind each gin stand.) The principal features and settings of saw-type lint cleaners are given in table 7, and their recommended installations and power requirements are given in table 8.

Flow-through air type.—The flow-through air type lint cleaner, more commonly known as the air-jet, has no saws, brushes, or moving parts. Loose lint is blown from the gin through a duct into a chamber of the cleaner. Air and cotton pass through a duct, make a sudden change in direction, and move across a narrow trash ejection slot (fig. 55). Foreign matter that is heavier than the lint is ejected through the slot by centrifugal force. A critical factor in the successful operation of an air-type lint cleaner is that a vacuum of 2 to 2½ inches measured on a water gage must be maintained on the discharge side of the cleaner. All air-type cleaners employ vane-axial fans and suction condensers to produce the vacuum required to operate them.

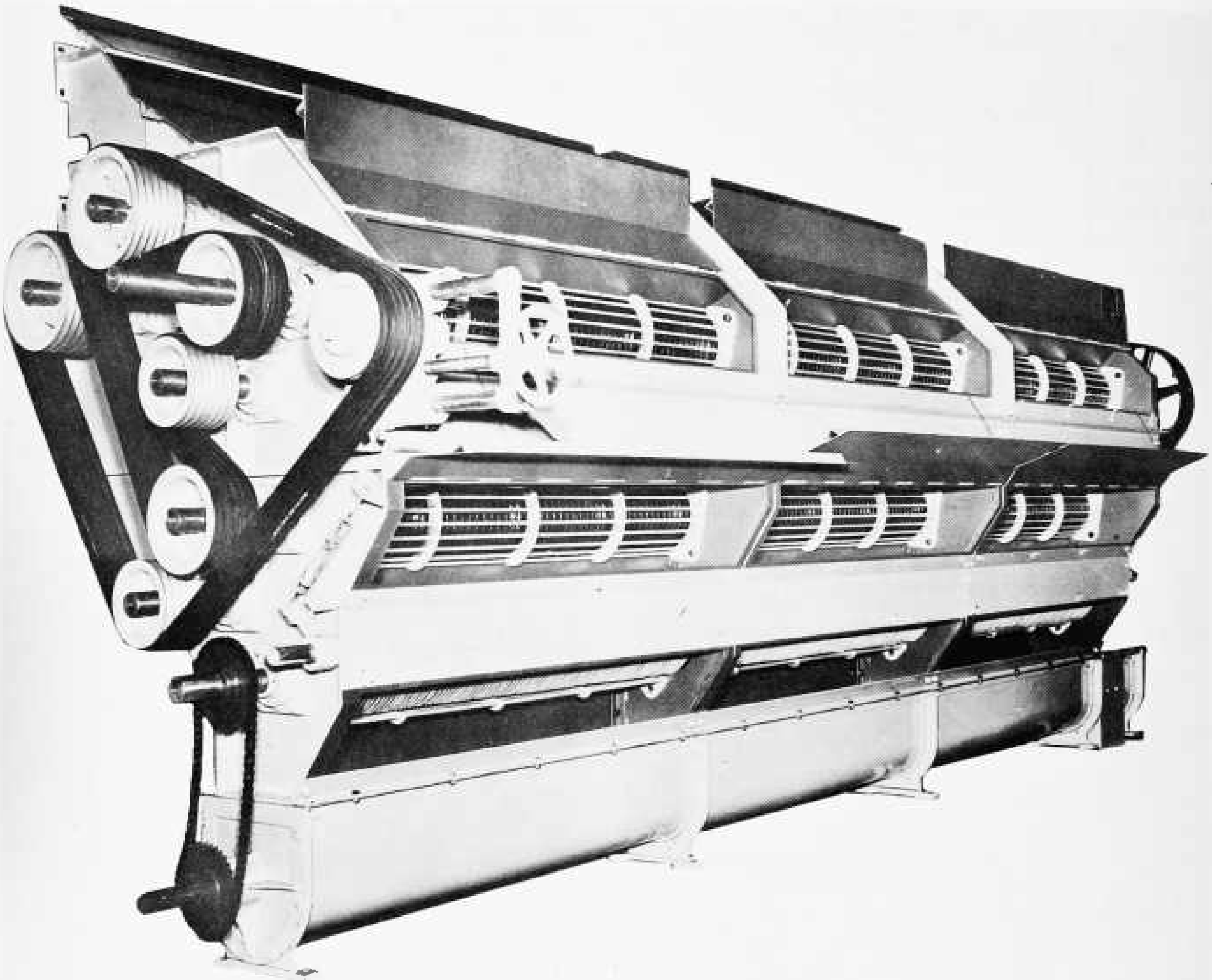


Figure 43.—**Open view showing grid-rods in stick remover attachment for bur machine.**

TABLE 7.—*Principal features and settings of saw-type lint cleaners*

Manufacturer and make	Saw diameter	Saw speed	Grid bars	Feed roll diameter	Settings: Feed roll to saws	Settings: Feed bar to saws	Settings: Feed roll to feed bar	Settings: Grid bar to saw (inches)	Doffing system
	In.	*R.p.m.*	*No.*	*In.*	*In.*	*In.*			
Continental Gin Co.:									
Sixteen D	16	[1] 800–850	8	4 7/16	1/16	1/16	0.020 inch spring loaded	1/16	Brush.
Model 580	12 1/2	700–800	5	2 5/8	1/16	1/16	0.0187 inch	1/16	Do.
DFB	16	1, 000	8	4 7/16	1/16	1/16	Spring loaded, 150 lb. tension.	1/16	Do.
Hardwicke-Etter Co.:									
Challenger	13 1/4	950	5	2 27/32	1/16	1/16	Floating spring loaded	1/16	Brush 18 inches, diameter at 1,540 r.p.m.
Conqueror	13 1/4	950	5	2 27/32	1/16	1/16	do	1/16	Brush, No. 1, 12 inches, diameter. Brush, No. 2, 18 inches, diameter.
Lintmaster	16	1, 000–1, 500	5	3 5/8	1/16	1/16	Roll fixed bar, 23 sections spring loaded.	1/16	Air blast, 14 inches to 16 inches W.G.
Lummus Cotton Gin Co.:									
Model 66	16	1, 200	6	4	1/16	1/16	0.005 inch floating spring loaded.	1/32	Air suction 2 to 2 1/2 inches W.G. vacuum.
Moss-Gordin Co.:									
Rebel and Commander.	14	800–1, 000	5	4 1/2	1/16	1/16	0.010 inch floating spring loaded.	1/32 top, 3/32 heel.	Brush 18 inches, diameter.
Cleanmaster and Super Cleanmaster.	14	800–1, 050	5	4 1/2	1/16	1/16	do	1/32 top, 3/32 heel.	Do.
Constellation, Super Constellation, Revelation, Super Revelation	16	800–1, 000	5	4 1/2	1/16	1/16	do	1/32 top, 3/32 heel.	Do.
Lodestar	16	800–1, 000	5	4 1/2	1/16	1/16	do	1/32 top, 3/32 heel.	Do.
The Murray Company of Texas, Inc.:									
Combing	12	700–980	8	3	1/16	0. 050–. 060	1/16 inch carding 0.010 grooved.	0. 050–0. 075	Brush.
Big 60	14 3/4	1, 000–1, 400	4	4 1/2	1/16	. 050–. 060	do	. 050–. 075	Do.
Big 72	17	880–1, 200	4	4 1/2	1/16	. 050–. 060	do	. 050–. 075	Do.
Big 84	17	880–1, 200	4	4 1/2	1/16	. 050	do	. 050–. 075	Do.
Seventeen	17	880	6	4 1/2	1/16	. 060	.010 inch	. 050–. 075	Do.

[1] Saws at 1,000 r.p.m. when used in split stream.

TABLE 8.—*Recommended installation and power requirements of saw-type lint cleaners*

Make	Condenser diameter	Clean air fan		Horse-power	Recommended installation	Capacity (bales per hour)
		Hp.	Type and size (inches)			
	Inches					
Continental Gin Co.:						
Sixteen D	24	5 per unit, 10–20 split stream.	V.A. 26	15, 20, or 25	Unit behind each gin stand single and tandem or back-to-back.	4–6, per unit 12–15 split stream.
Model 580	20	3 per unit	Prop. 18	15	Unit	1–2.
DFB	Battery	3		20	Battery units	6–8.
Hardwicke-Etter Co.:						
Challenger	20	3–15 per battery.	V.A. 28, 1 to 3/battery.	7½–10	Unit behind each gin stand for single stage lint cleaner.	2½–5.
Conqueror	Two 20's	5 each	V.A., 2 to 5, 28; 2 to 5, 36/battery.	15	Unit behind each gin stand for 2-stage lint cleaner.	2½–5.
Lintmaster	30	3	V.A. 28	25	Battery unit single, tandem, or split stream.	6–8, per unit.
Lummus Cotton Gin Co.:						
Model 66	24	3–7½	V.A. 18	15–20	Behind each gin stand single and tandem.	4–8 per machine.
Model 66	24	7½–50 as required.	V.A. 18, 36, 42.	15–20	Battery units, single and split stream.	4–8 per machine.
Moss-Gordin Co.:						
Rebel	40	5	C.A. 36	20	Battery unit	3–4.
Commander	40	5 or 7½	C.A. 36	20	Battery unit or tandem, split stream.	6–8.
Cleanmaster	40	5–10	C.A. 36 or 42	20	Battery unit or tandem	5.
Super Cleanmaster	40	7½	C.A. 36 or 42	2–20	Battery unit or tandem, split stream.	10–12.
Constellation	50	7½–10	C.A. 42	25	Battery unit or tandem	7–8.
Super Constellation.	50	7½–10	C.A. 42	2–25	Battery unit or tandem, split stream.	18–20.
Revelation	50	7½–10	C.A. 2–42	25	Battery unit and includes battery condenser.	7–8.
Super Revelation	50	7½–10	C.A. 2–42	2–25	Battery unit, split stream, includes battery condenser.	18–20.
Lodestar	24	10	V.A. 26	15	Unit behind each gin stand, tandem.	7.
The Murray Company of Texas, Inc.: Type F. Combing Lint Cleaner	20				Unit behind each stand	2–4.

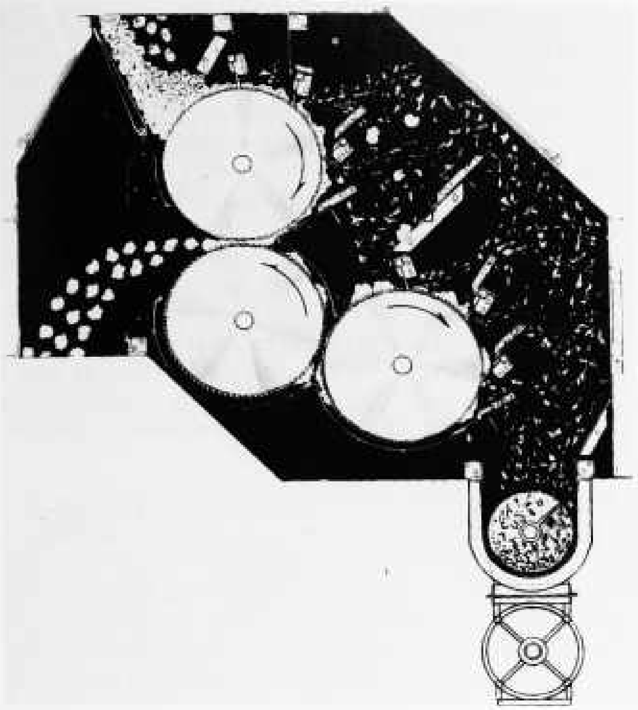


Figure 44.—Cross section view of stick-and-green-leaf machine.

Tandem Lint Cleaning

Lint cleaners are generally grouped into two categories, unit and bulk (battery). The unit machine implies that there will be one unit for each gin stand. A lint cleaner that receives lint from two or more gins is referred to as a bulk lint cleaner (fig. 56). Lint cleaners, either unit or bulk, placed in series so that the same lint passes through both of them result in what is commonly called tandem lint cleaning.

Popular tandem installations are:

(1) Unit air, saw bulk
(2) Unit air, unit saw
(3) Unit saw, saw bulk
(4) Unit air, unit saw, bulk saw
(5) Unit saw in series
(6) Unit saw in series, bulk
(7) Unit air, saw bulk, saw bulk
(8) Unit saw, saw bulk, saw bulk
(9) Unit saw or bulk saw back-to-back

The use of one or more saw-type lint cleaners is an accepted practice, but the use of more than two in series should be discouraged. For high-capacity gin stands, it is advisable to install the

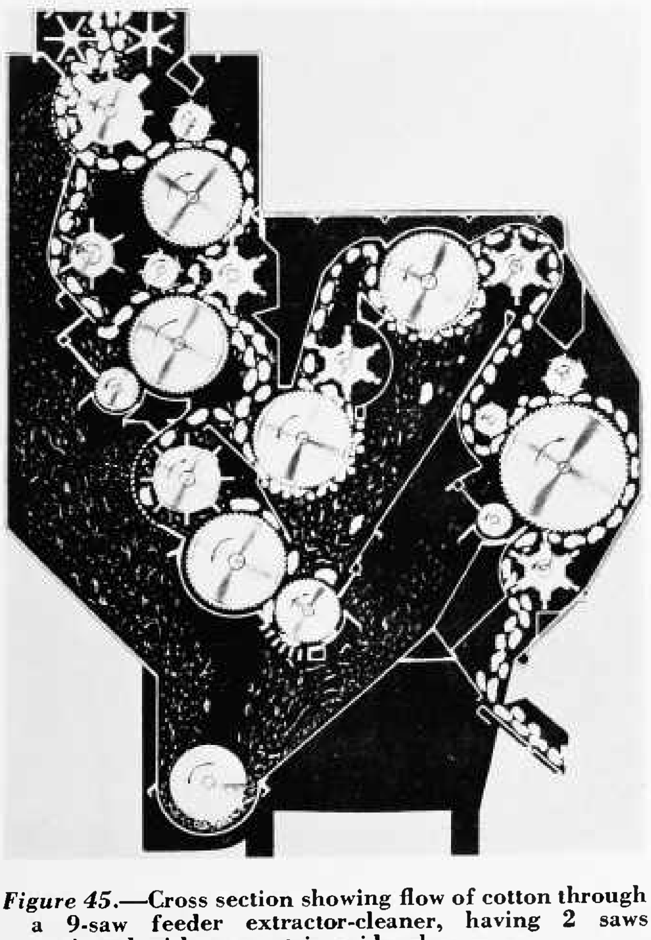


Figure 45.—Cross section showing flow of cotton through a 9-saw feeder extractor-cleaner, having 2 saws equipped with concentric grid-rod screens.

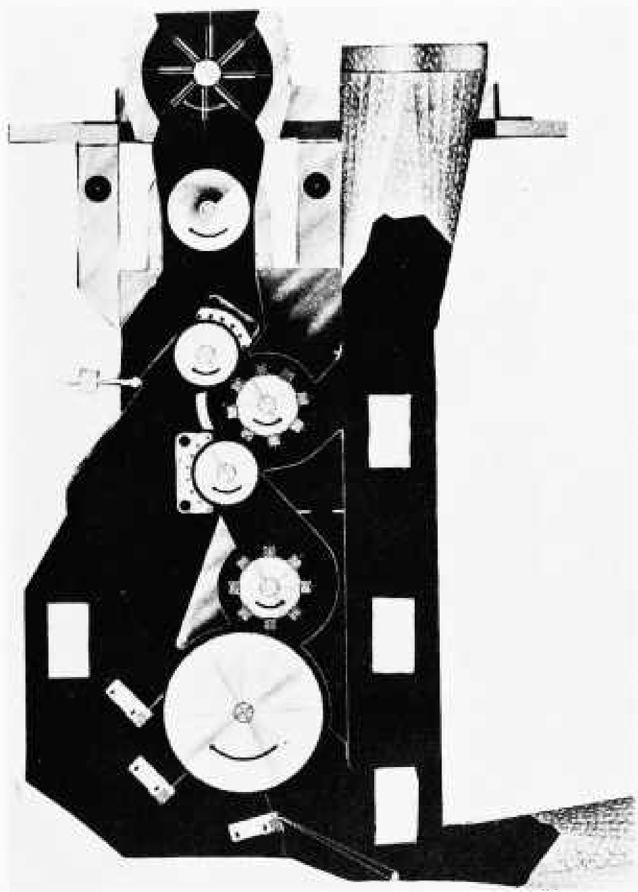


Figure 46.—Cross section view of unit stick-and-green-leaf machine.

larger machines as units, and the bulk cleaners back-to-back with a common lint flue. In that way the lint is divided, and each saw receives only half the cotton. This type of installation is often referred to as a "split stream." With two-stage or tandem lint cleaning, the fibers should not pass over more than two saws.

Lint Cleaner Waste

Effectiveness of trash removal and grade improvement benefits resulting from use of lint cleaners are well established. But when grades are improved, bale weights and values are affected. Bale weights are reduced from 7 to 50 pounds or more per bale depending on harvesting practices, number of lint cleaners, and grades of cotton being ginned. Thus, improvements in grade may be offset by losses in bale weight.

With tandem saw-type lint cleaners, the first cleaner removes the most weight: the second, about half as much as the first: and the third, about half as much as the second. The foreign matter removed is composed of motes, fine leaf particles, grass, and green leaf in varying amounts, depending on the method of harvest and the condition of the cotton.

Operation and Maintenance

For best performance and service, follow carefully the recommendations of the manufacturer of the machine you use. Know your machine; how it works; and its operating principles, settings, and speeds.

SEPARATORS AND DROPPERS

By D. M. Alberson, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Gin separators are usually of three types, or are combinations of the three: (1) Those in which seed cotton carried in the air line adheres to a curved section of screen or perforated metal and is wiped off by rubber flights on a revolving reel (fig. 57); (2) those in which seed cotton is blown or sucked into a section containing a revolving screen drum. The area of the drum is large enough

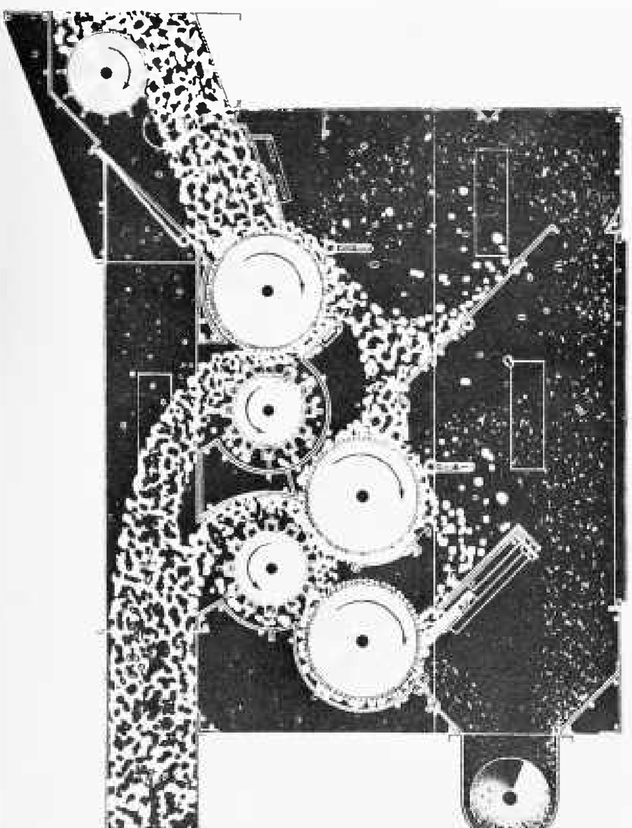


Figure 47.—Cross section of gravity-fed-type stick, leaf, and hull remover showing flow of cotton through the machine.

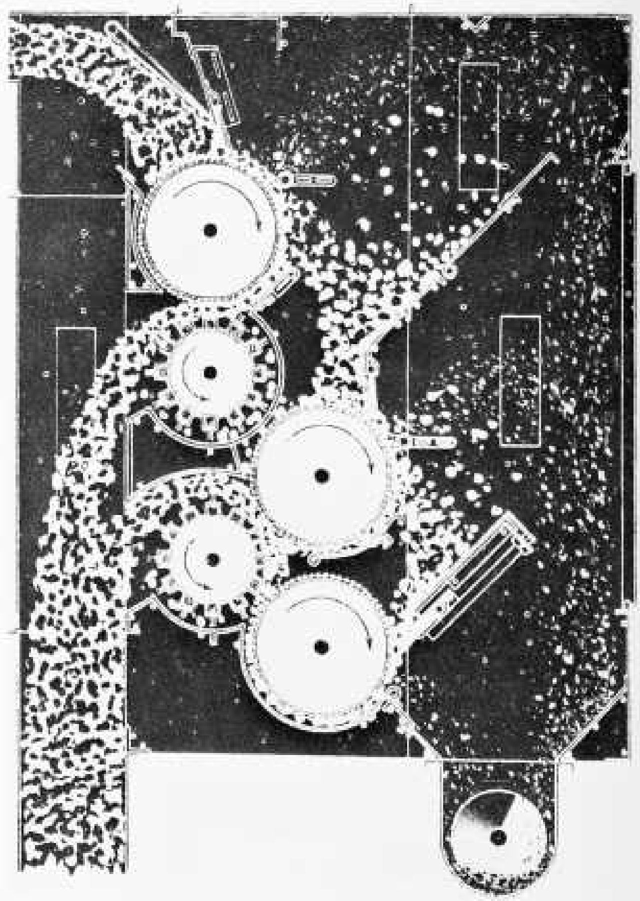


Figure 48.—Cross section showing flow of cotton through an air-fed type of stick, leaf, and hull remover.

to allow the air to pass out through the screen at a low enough velocity that cotton does not adhere to the drum and is allowed to fall off into the dropper section (fig. 58); and (3) those in which seed cotton is blown or sucked into a unit containing a curved screen or grid section. The screen and the air flow are so adjusted that this section is self cleaning or the seed cotton flow action keeps the section wiped clean (fig. 59).

In the first type, the wipers do not require frequent adjustment or replacement, because they are not subjected to high temperatures except when there is a fire in the separator or when the separator is being used as a blow-in unit to receive cotton from the drier. Rubber flights on the upper or reel shaft should be examined periodically to see that they are strong enough to wipe the screen lightly and keep the cotton removed from the screen at each passage. Rubber flights on the reel section have slots, so that when bolts holding them are loosened the flights may be pulled out toward the screen if they become so cupped or worn that they are not touching the screen. When the rubber flights on the reel become cupped or worn, they can sometimes be removed and turned over to give further service. If, however, they are broken or cannot be adjusted, they should be replaced immediately.

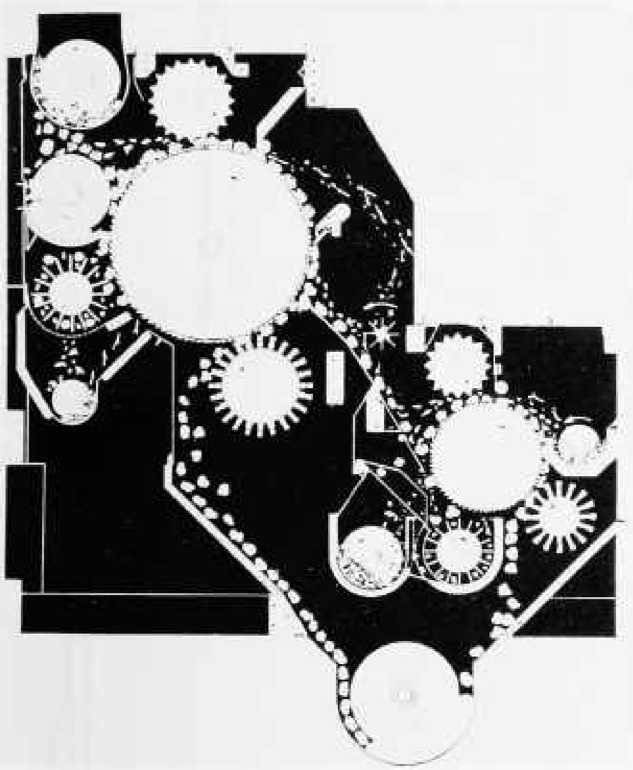


Figure 49.—**Cross section of "sling-off" type of extractor-cleaner.**

Rubber flights in the lower or vacuum section of the separator require more careful attention and more frequent adjustment or replacement than do rubber flights in the reel section of the separator. In the lower section, the rubber flights must be kept in good condition so that they press against the sides of the curved, concave sheets forming the front and rear body of the vacuum section. When new rubber flights are installed in the vacuum section, they should be properly set so that the edges of the flights rub securely against the curved or concave sheets. They should be set out sufficiently so that when they pass the curved sheet they will bend approximately one-half inch and not more than three-fourth inch from a straight line. They should not be required to bend or flex unduly. When rubber flights in the vacuum section are checked or replaced, the rubber wipers on the ends of the vacuum cylinder should be inspected and replaced if they are damaged or worn.

When separator choking occurs, it is usually because the rubber flights in the lower or vacuum section have become so damaged that they are not properly sealing the curved sheets. Thus, the cotton remains in the reel section and is not discharged through the vacuum section. Vacuum wheels or droppers are used to drop seed cotton or seed into an air stream. They are also used as a sealer to prevent escape of air while the seed cotton or seed is metered from an air stream into an "out-of-line" type of gin machine.

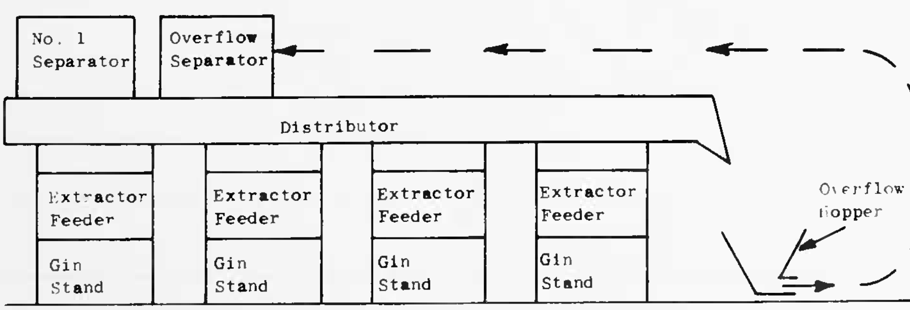


Figure 50.—**Diagram showing continuously operating "live overflow" for returning overflow cotton directly to the distributor. The gin drying and cleaning system is bypassed.**

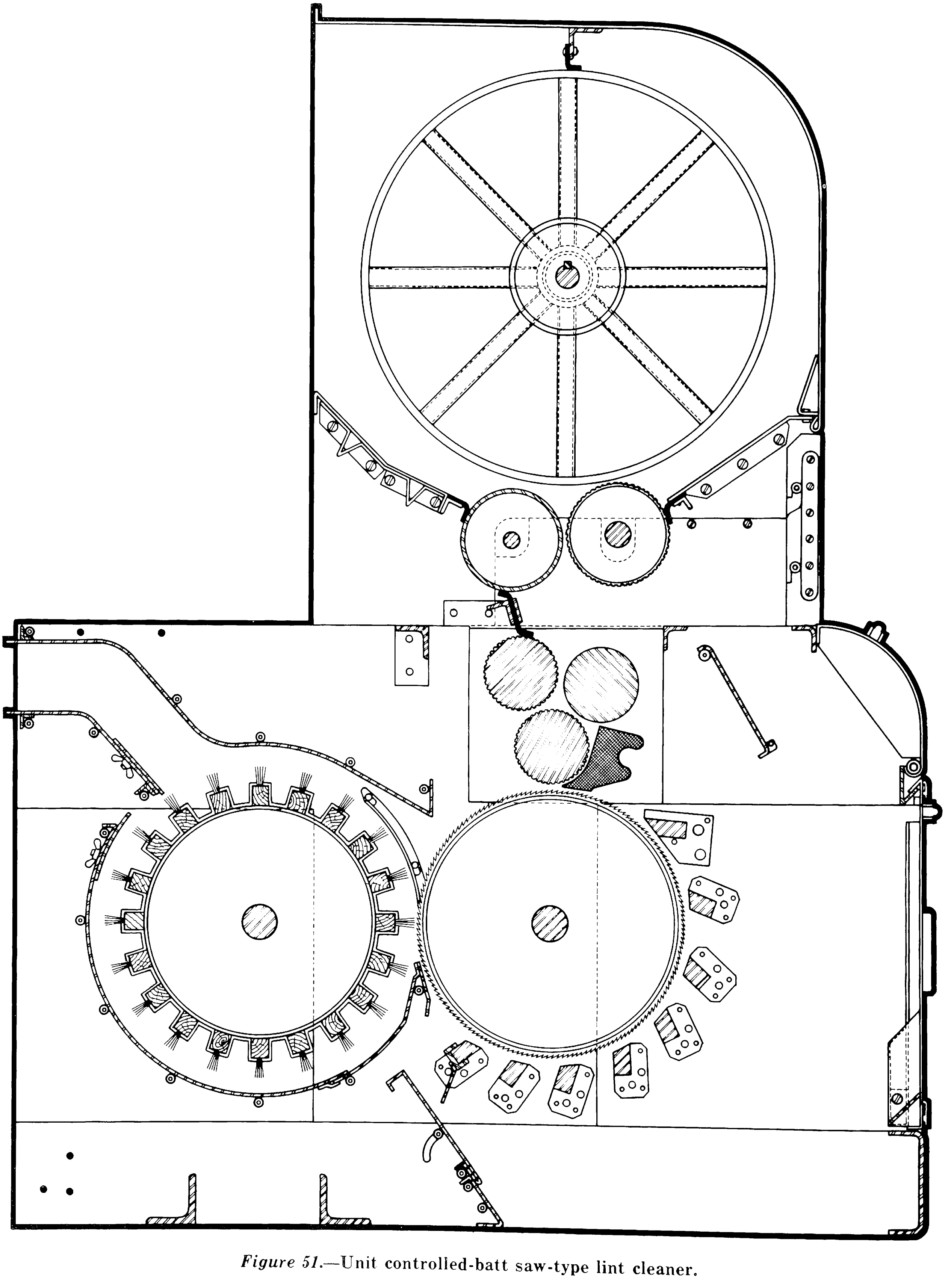


Figure 51.—Unit controlled-batt saw-type lint cleaner.

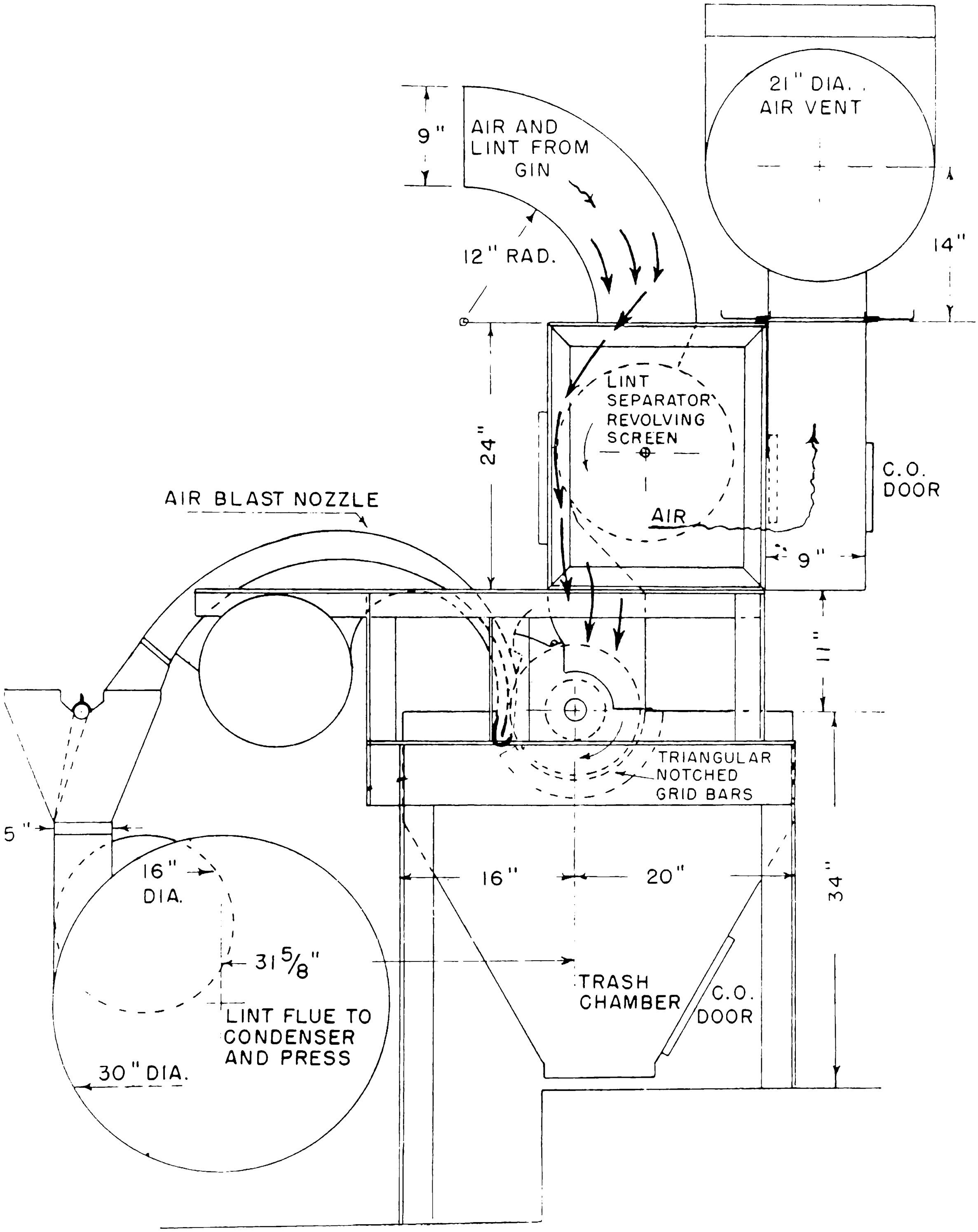


Figure 52.—**Unit flow-through saw-type lint cleaner, USDA Cotton Ginning Research Laboratory, Stoneville, Miss.**

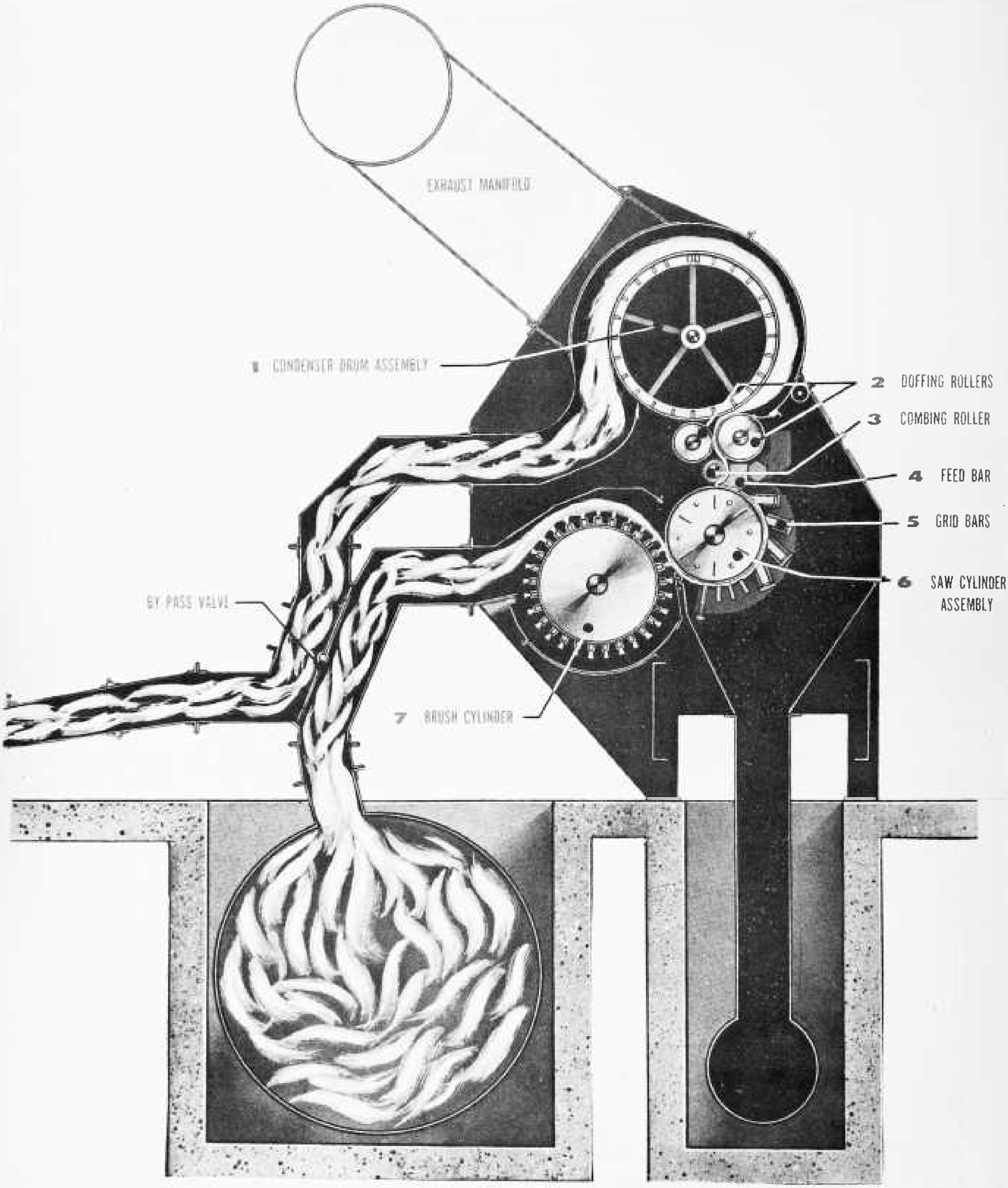


Figure 53.—**Unit saw-type lint cleaner.**

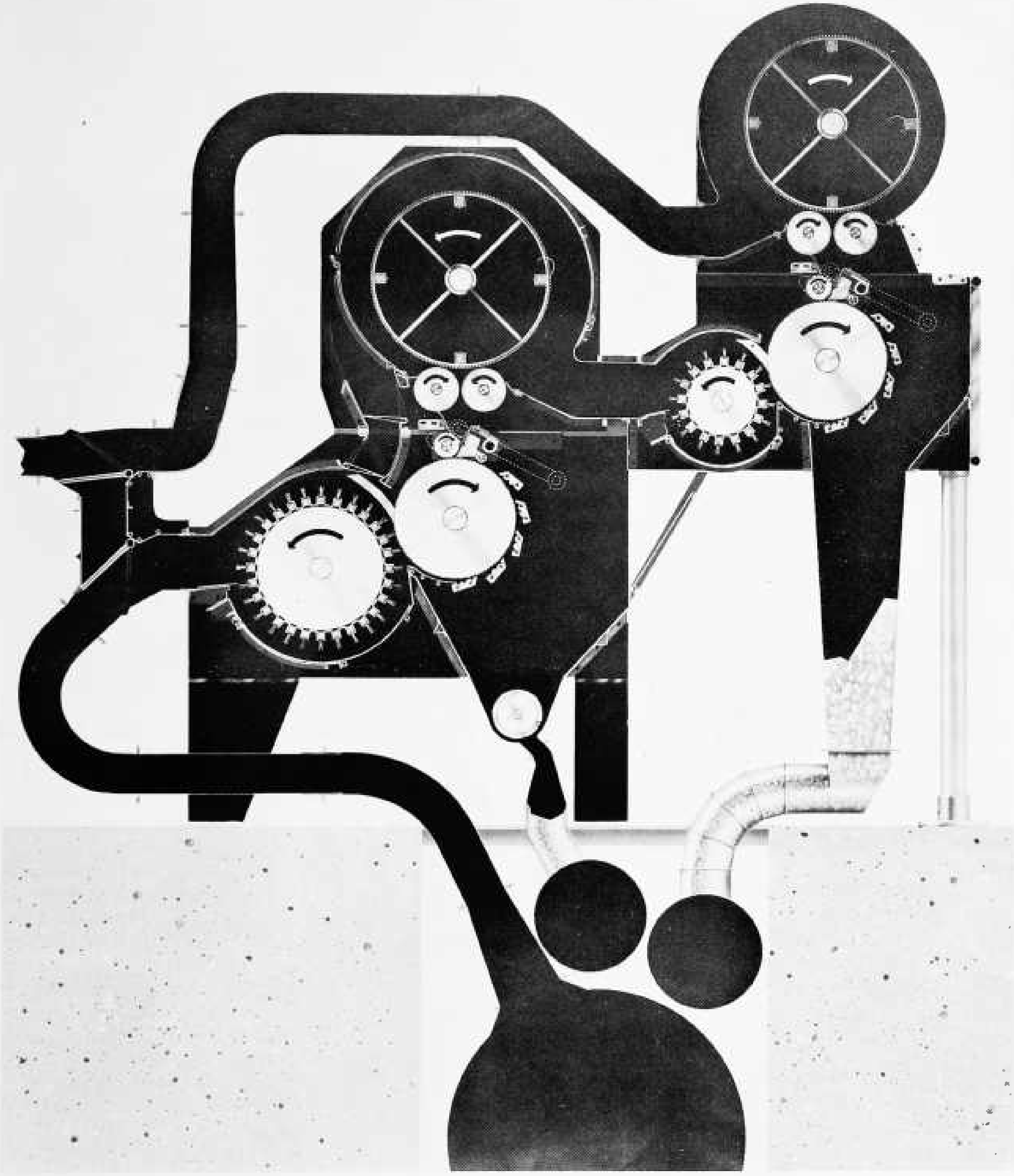


Figure 54.—Unit saw-type lint cleaners in series.

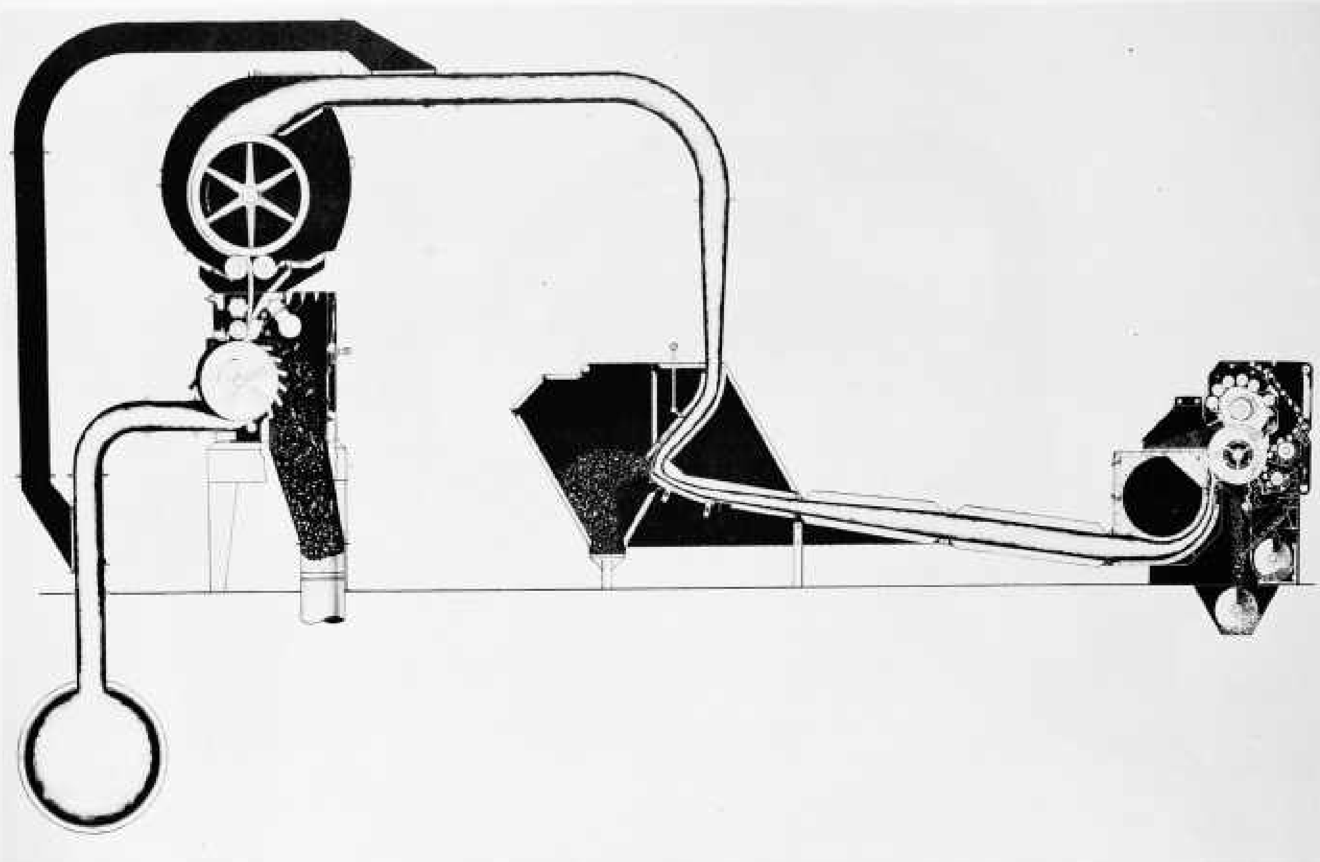


***Figure 55.*—Installation of unit flow-through air type and unit suction doffing saw-type lint cleaners in tandem.**

The chief maintenance and repairs necessary in the second and third types of separators are in the screen sections and the vacuum dropper flights and seals.

Vacuum wheel droppers, such as shown in figure 60, are of various sizes, ranging in width from 6 to 72 inches. They are based on the same principle as the vacuum section of the separator. The same general information regarding rubber flights applies to these droppers. To replace the flights, put a straight edge lengthwise across the top of the vacuum wheel. Turn the wheel so that the flights to be replaced will be in a vertical position. Then set flights so that the edges will be approximately one-eighth inch from the bottom of the straight edge. Some of the latest models of vacuum wheel droppers now use quick change flashing strips that make repair and maintenance quicker and easier. Some models also incorporate a deflector feeder between vacuum feeder and the hot-air stream, thus lengthening the life of the feeder flights.

Separators and vacuum droppers used in the pneumatic seed cotton handling systems in the gin may constitute a major source of power waste. Continued upkeep, inspection, and repair are necessary to reduce air leakage. Even new and well-sealed separators have a significant intake and leakage of air through the vacuum dropper section. A 35-percent loss at a separator is not uncommon.

A periodic check of all separators and vacuum droppers will greatly reduce downtime due to chokages caused by improper settings or worn parts in the separators or the vacuum droppers.

GIN STAND

By V. P. Moore, *cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

The gin stand is the heart of the gin plant. The capacity of the plant depends on the stands being in good condition and in proper adjustment. The quality and potential spinning performance of the

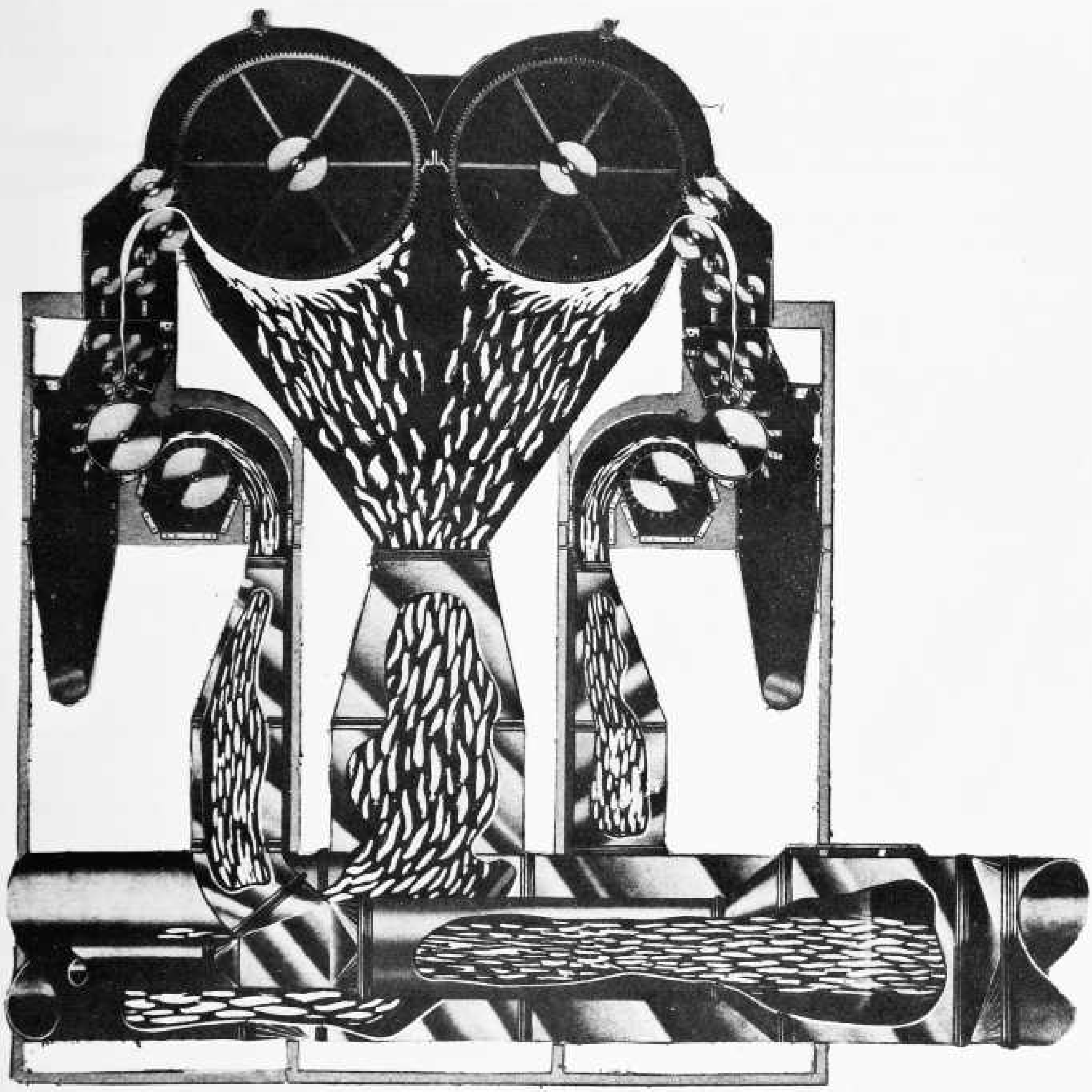


Figure 56.—**Bulk saw-type, back-to-back, split-stream lint cleaners.**

ginned lint depend largely on the condition, adjustment, and proper operation of the stands. The gin stand can affect every commonly measured fiber property except fiber strength and micronaire.

Machinery manufacturers will furnish up-to-date operating manuals that give detailed instructions on adjusting and setting their equipment.

When installing new gins, make sure that the saw line shaft will run at the recommended speed. A speed of 20 to 25 revolutions per minute above or below the manufacturer's recommendations will at times make appreciable differences in performance.

All stands are adjusted before leaving the factory, but during handling and shipping the settings may change. It is therefore important, even in new gins, to check all settings and to make necessary adjustments in accordance with the manufacturer's instructions. A number of points are common to practically all gin stands, and attention to these details will contribute to better operation and preservation of quality. Some of the more important adjustments and settings for various makes and models of gins are shown in figures 61 through 65.

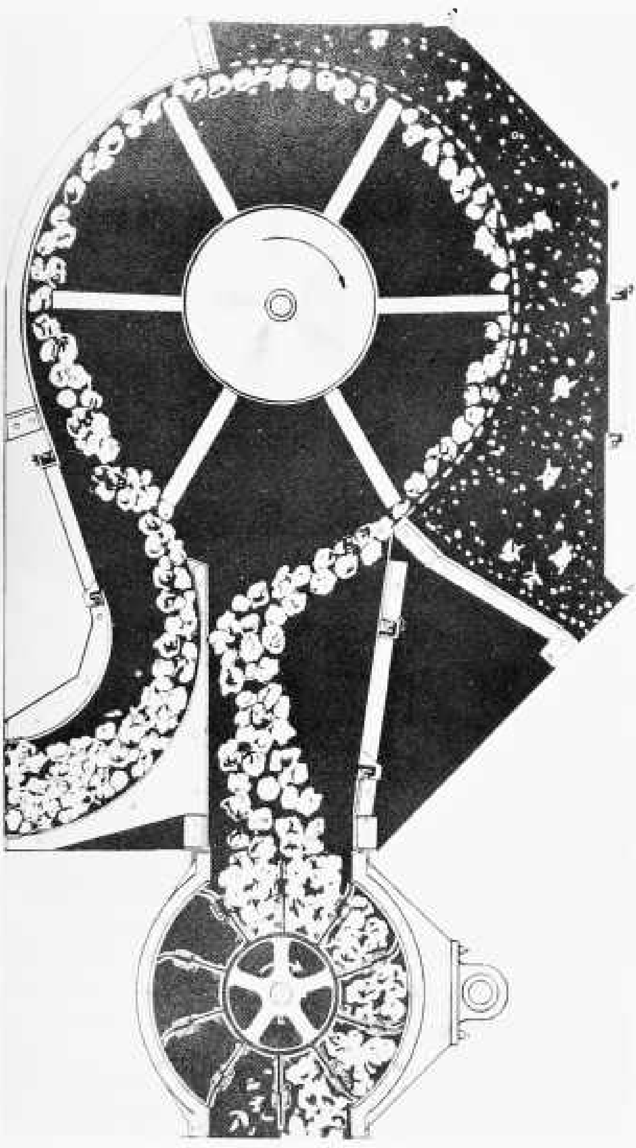


Figure 57.—**Seed cotton separator with curved screen and revolving reel.**

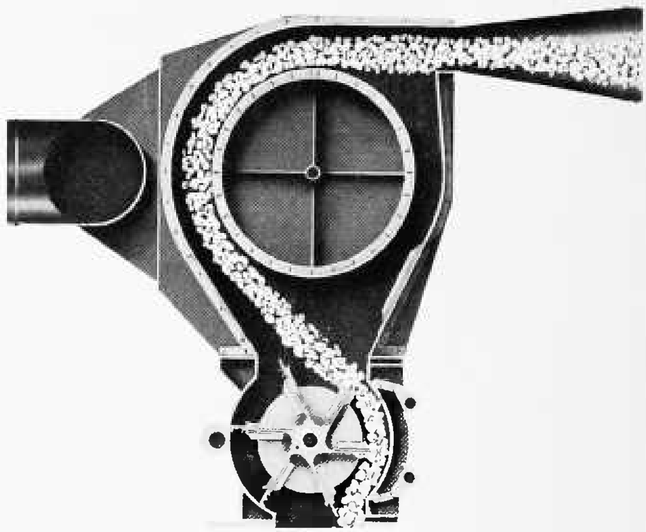


Figure 58.—**Revolving screen drum separator.**

Gin Breast

After installing new stands or repairing old ones, be sure that the lateral adjustment of the breast is correct. The saws should be positioned in the center of the rib slots. After visual inspection, the saw cylinder should be rotated slowly by hand to make certain that none of the saws rub the ribs.

When replacing a broken rib, care should be taken to install the replacement so that the saw opening is the same on each side. It is generally more satisfactory to have worn ribs replaced by the manufacturer. A matched set of ribs installed by factory-trained personnel will usually give better service than unmatched sets installed without proper jigs.

Never move the breast into ginning position when there is seed cotton in the roll box, unless the saws are running. To do so may damage the ribs.

On many gins the picker roller is adjustable. In some cases it can be adjusted by means of a ratchet lever while the gin is in operation. Generally speaking, it should be set as far away from the saw or huller ribs as possible without dropping cotton. The closer the picker roller is set to the huller ribs, the less space there is for hulls to fall out and the more the saw will break the hulls up and pull small pieces into the roll box with the cotton.

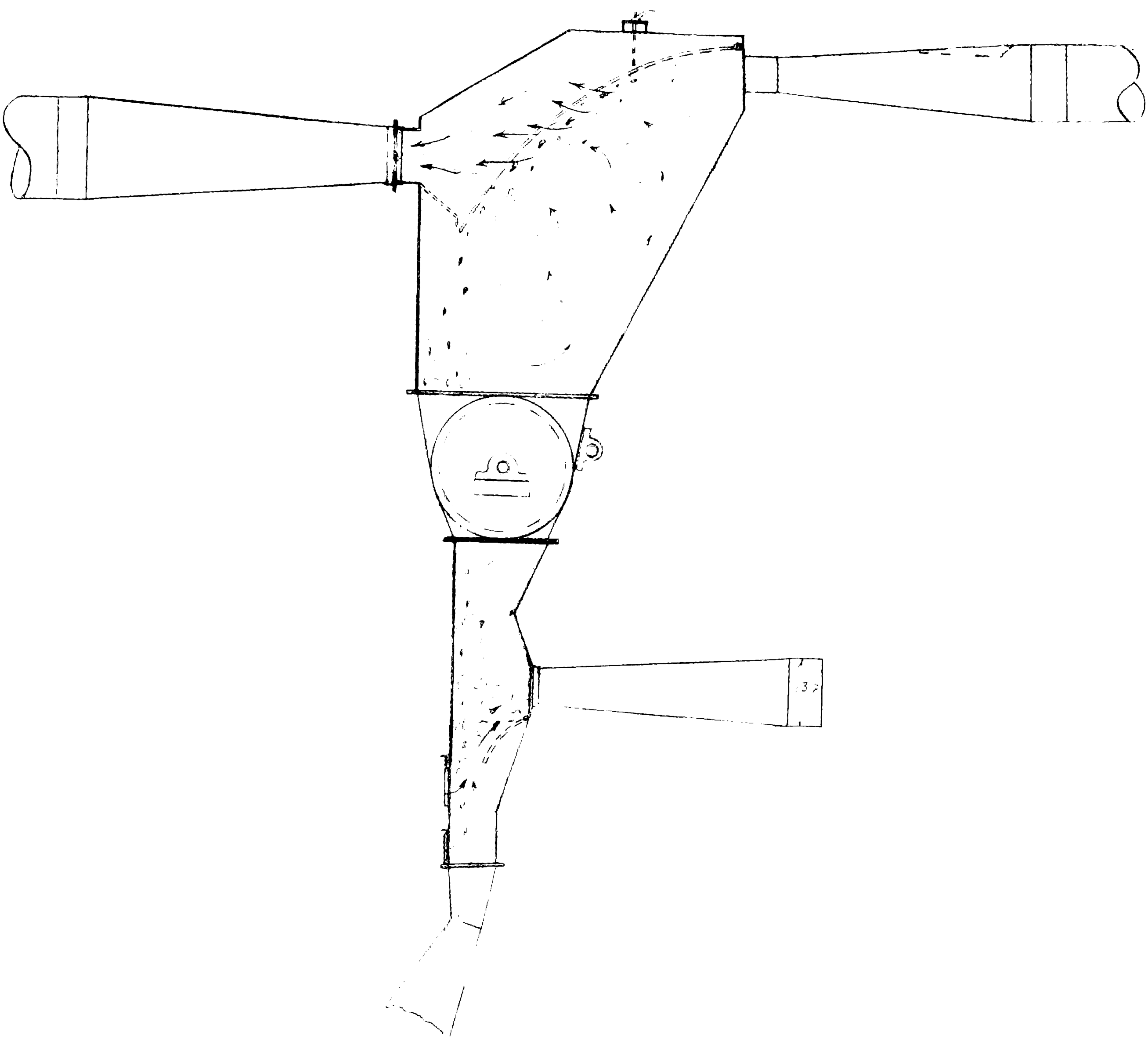


Figure 59.—**Separator with curved screen or grid section.**

The seed fingers, or lambrequin, should be set as wide open as possible but close enough that the seed will be clean. When building up a new roll, close the seed fingers and then slowly open them as widely as possible, consistent with clean seed, to allow the cleaned seed to fall out of the roll box. Holding seed in the roll box longer than necessary will reduce the ginning rate and cause tight seed roll operation, which reduces the value of the cotton.

The relation of the saws to the ribs is critical. Consult the manufacturer's manual to determine which of the dimensions shown in figure 66 should be checked to insure proper saw-rib relations.

Gin Saws

Saws should be checked to make sure they are properly trained and are running in the middle of the rib slots at the recommended speed. The distance from where the saws project through the ginning rib to the top of the rib must be correct. If the distance is not correct, capacity will be reduced and fibers will be damaged. The distance the saws project through the huller ribs should also be checked. If the saws project beyond the desired distance, an excess of hulls and sticks will be pulled into the roll box. If the saws do not project far enough, ginning capacity will be reduced, seed cotton will fall out of the front, and the huller ribs may choke.

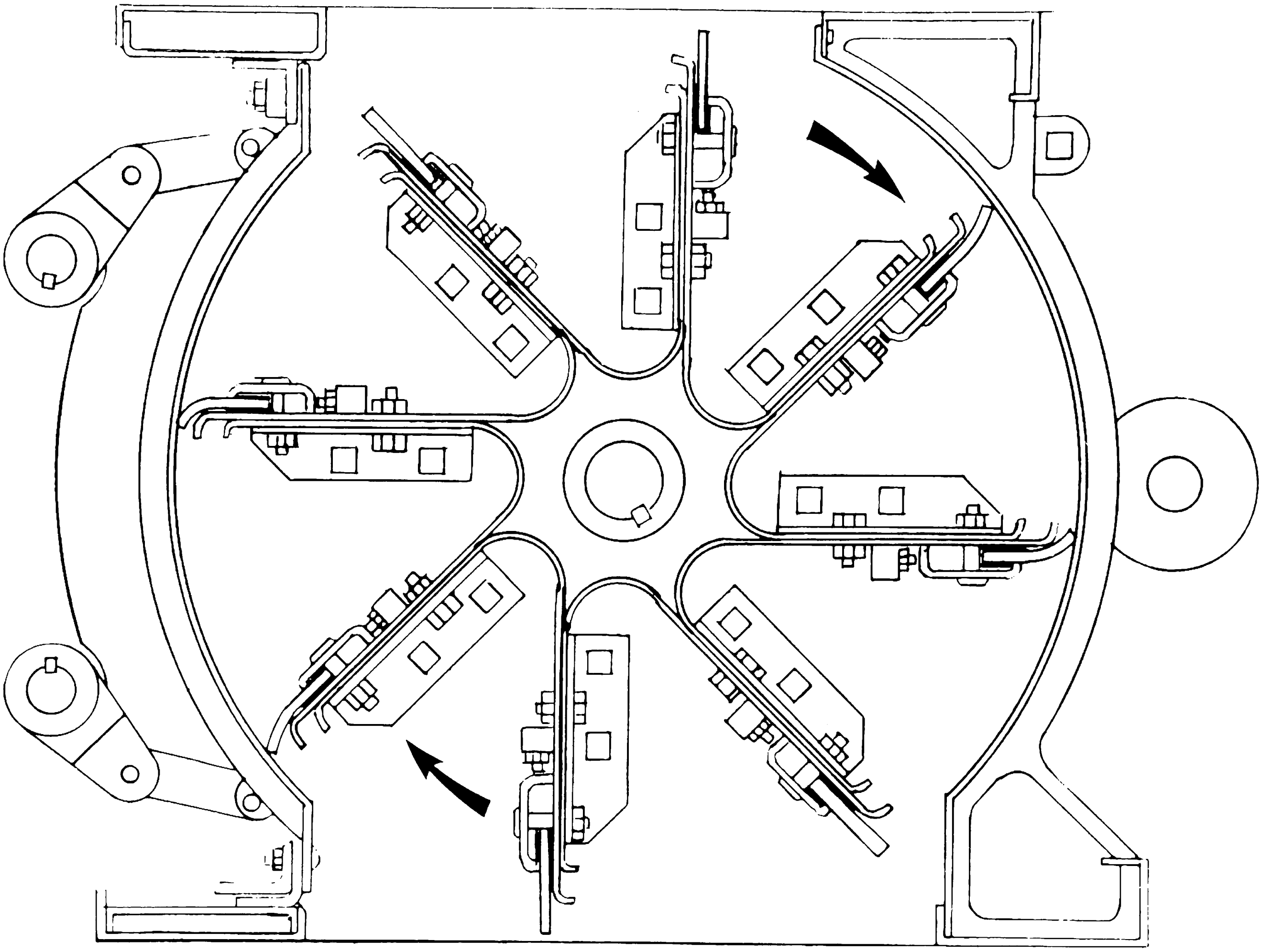


Figure 60.—**Vacuum wheel dropper.**

The pitch and shape of the saw teeth are also important from the standpoint of capacity and cotton quality. To insure good ginning, the teeth must pass through the ribs at the proper angle. The point of the tooth should enter the ginning rib slightly ahead of the throat (fig. 67). If the saws are improperly filed or the saw-rib relationship is improperly adjusted so that the throat of the tooth enters the rib ahead of the point, the resulting cutting action will reduce capacity, will break fibers, and may cause chokages at the top of the ginning ribs. In many instances, the moting action of the gin stands is affected by saws being tilted too far forward or backward.

Saws should be sharpened by the manufacturer. However, if a ginner wishes to sharpen his own saws or have them sharpened by other than factory personnel, extreme care should be taken to maintain the original tooth shape and pitch. Be especially careful that gin breasts and saw cylinders are reinstalled on the same gin stand they came from.

The number of bales that can be ginned between saw sharpenings depends on the type of cotton being handled. Rough cotton causes more wear than clean cotton. Usually, saws should be sharpened after 400 to 600 bales per gin stand have been ginned. Sharpening reduces the diameter of the saw. After several sharpenings, the ginner will find that the gin capacity has been so reduced that new saws are needed. Many ginners find that it is poor economy to continue to use saws that have been sharpened more than three or four times.

Saws should be examined frequently, and bent teeth should be straightened or even broken off so that lint will not remain hung in them. Lint that cannot be doffed will tend to collect in the lower portion of the gin ribs. If this lint is allowed to accumulate, the friction of the gin saw will cause it to catch fire.

1. SAW PROJECTION THROUGH HULLER RIB--3/8"
2. GRAVITY MOTE BOARD TO BRUSH 1-1/2"
3. OVERHEAD MOTE BOARD TO SAW---- 3/16"
4. GINNING POINT TO POINT OF RIB------- 2"

SAW SPEED------------------700 r.p.m.

BRUSH SPEED--------------- 1,850 r.p.m.

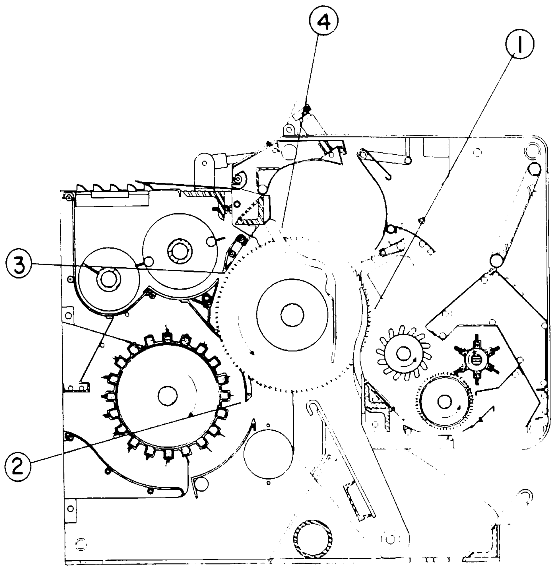


Figure 61.—**Important settings and adjustments for the Continental Comet Gin.**

When changing saws, it is best to keep saws of the same diameter on a mandrel. If new saws are mixed with saws that have been reduced one thirty-second or one-sixteenth inch in diameter, it will be impossible to properly adjust the gin breast to the saws.

Doffing System

Brushes.—For proper doffing, the brush should mesh to the depth of the saw tooth (fig. 68). Belts driving the brush must be kept tight to maintain proper speed for doffing and to provide sufficient air velocity in the lint flue to prevent backlash.

The brushes should be examined periodically and replaced if the bristles are badly worn. They should be returned to the manufacturer for repair if facilities are not available in the field for rebalancing them. Brushes that are out of balance will cause excessive vibration and bearing wear.

When replacing brushes in the stand, take care to adjust the shaft and bearings to eliminate lateral motion or "end play."

Air-blast nozzles.—The manufacturer gives specific instructions for setting the air-blast nozzles for each gin. Follow these instructions to insure proper doffing and moting.

1. SAW PROJECTION THROUGH HULLER RIB
   (a) ABOVE KNUCKLE---- 5/16"
   (b) BELOW KNUCKLE---- 3/16"
2. KNUCKLE BOTTOM TO SAW ENTRY------ 2-3/4"
3. FRONT OF GIN RIB TO FRONT OF SAW 2-7/16"
4. AIR BLAST TO SAW------------ 1/8" TO 5/32"
5. FRONT OF NOZZLE TO SAW----- 1/16" TO 3/32"
6. GINNING POINT TO POINT OF RIB---- 2-5/16"

SAW SPEED--------------- 700 r.p.m.

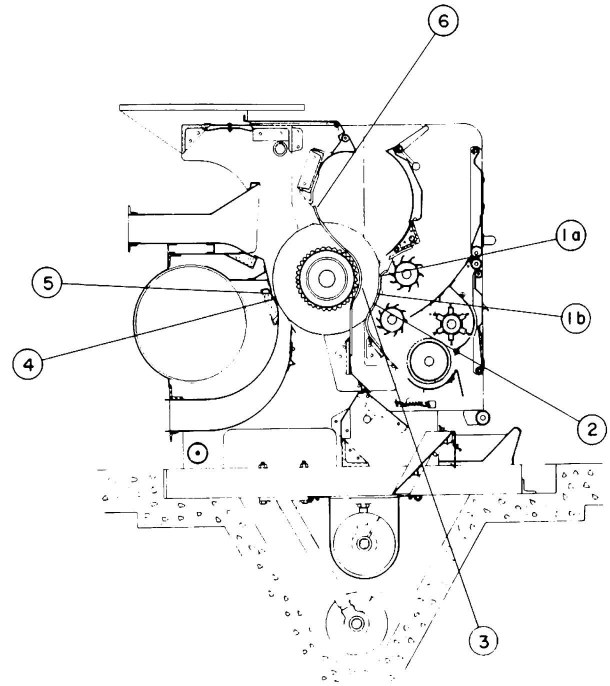


Figure 62.—**Important settings and adjustments for the Gordin Unit System.**

Keep the nozzle clean and free of tags, and avoid damaging it or the gin saws when removing a saw cylinder. Many tags may be prevented by periodically removing the cap from the end of the air-blast trunk and starting the fan to blow out the accumulation of dust and fly.

Check the air-blast pressure frequently to make certain that correct doffing pressure is being maintained. For some gins the correct pressure will range from 10 to 18 inches of water. Sufficient pressure should be maintained to give proper doffing, but excessive pressure will waste power. Manufacturers can supply an adjustable air-blast fan valve by which the air-blast pressure can be readily adjusted (fig. 69).

It is important that the air-blast fan intake be equipped with a screen to keep foreign matter out of the fan. It is equally important that the screen be kept clean.

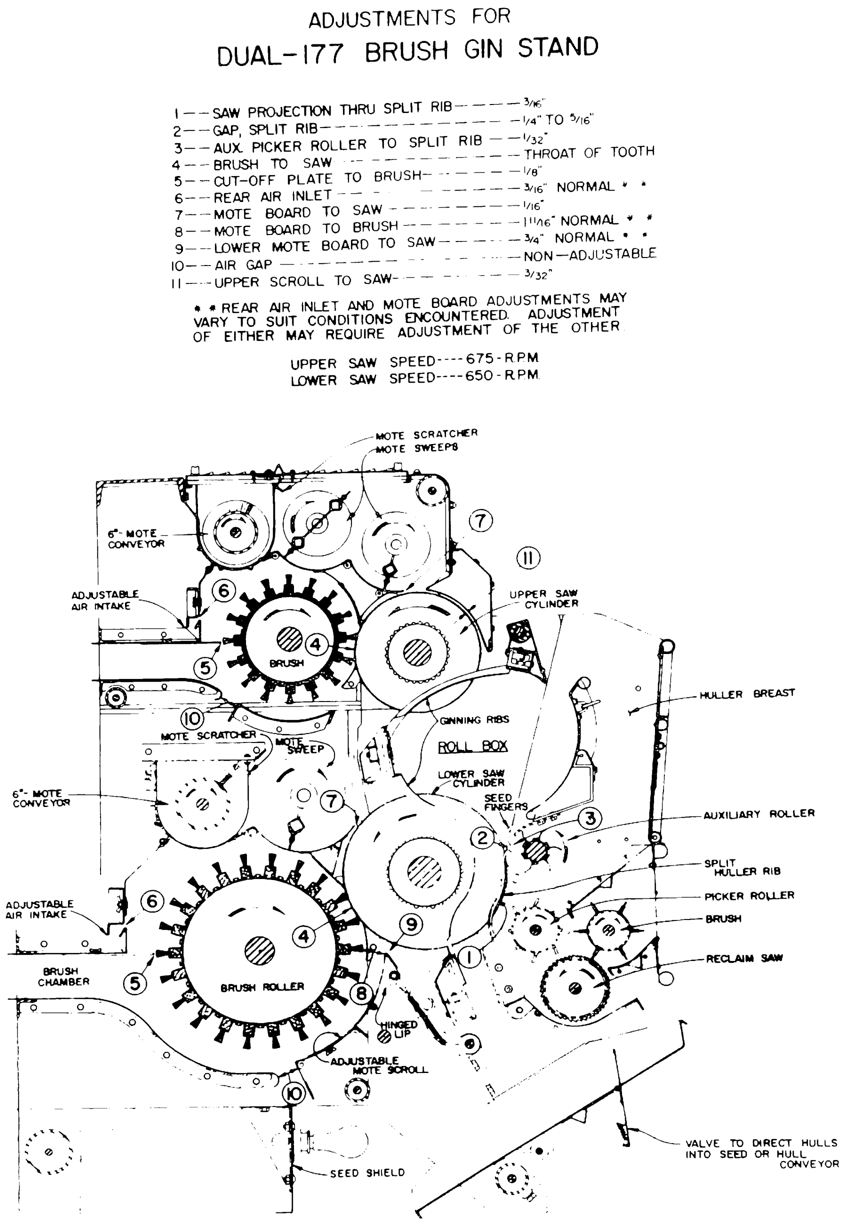


Figure 63.—**Important settings and adjustments for Hardwicke-Etter Dual 177.**

Moting System

Modern gins are equipped with both overhead and gravity moting systems. The seals, whether dropper wheel or roller type, on the overhead moting system should be kept in good condition. In some gins, pressure is maintained in the overhead moting chamber; and the system will not operate properly if the seals leak excessively. Honeydew sometimes causes motes to be sticky and builds up on the moting bars, wiper flights, and roller seals. This makes the moting system almost ineffective. Under extreme conditions the buildup will cause chokage in the gin ribs. When sticky motes are encountered, clean the moting bars and seals frequently with fine steel wool and coat the surfaces with a light textile oil.

Proper adjustment is also important on gins having a mote board in the gravity moting system. To adjust the mote board, open it slowly until it starts dropping some lint; then close it slightly. The wider open the mote board can be set without losing lint, the more effectively the system will operate.

The high-capacity gin stands now on the market are the result of years of research. They will give good service so long as they are kept in good condition and in proper adjustment. The capacities for the 1962 model gin stands recommended by the gin machinery manufacturers are shown in table 9. The gins can be made to gin faster, but the quality of the cotton will be reduced.

TABLE 9.—*Saws and capacities of various makes and models of 1962 gin stands recommended by manufacturers* [1]

Manufacturer	Saw cylinders	Saw diameter	Saws	Capacity
	Number	*Inches*	*Number*	*Bales/hour*
Continental Gin Co	1	16	79	4
Do	1	16	119	6
Do	1	12	120	3–3.5
Moss–Gordin Co	1	16	75	3.5
Do	1	16	140	6–8
Hardwicke-Etter Co	1	12	100	2
Do	1	12	120	3
Do	2	[2]	177	5
Lummus Cotton Gin Co	1	12	88	4–5
The Murray Company of Texas, Inc	1	18	80	4.5–5
Do	1	18	120	5–6
Do	1	12	120	3

[1] These data are averages and will vary considerably for different types of cotton. Clean, dry cotton gins much faster than trashy, damp cotton.
[2] 12 bottom; 11¾ top.

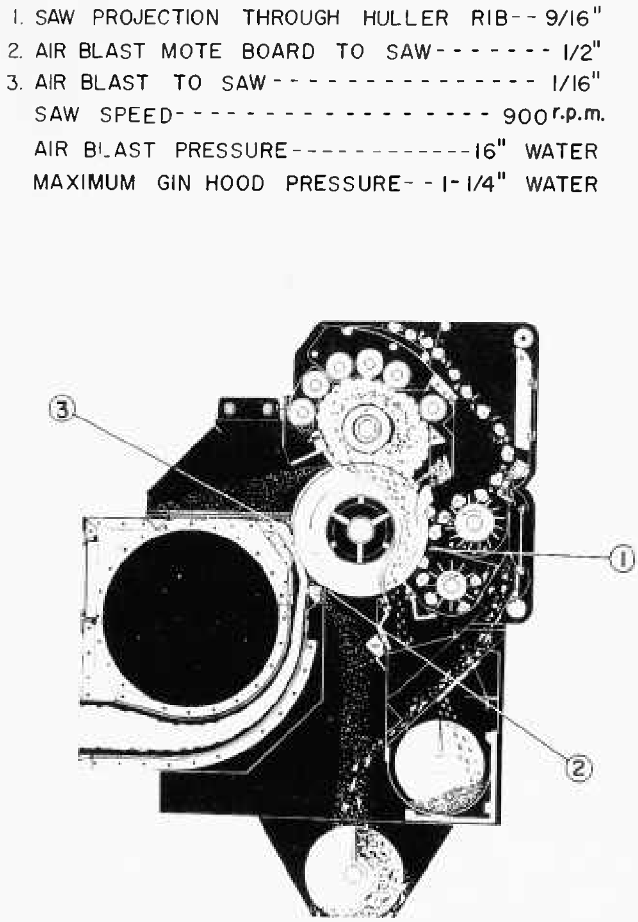


Figure 64.—**Important settings and adjustments for the Lummus Super 88.**

PACKAGING

By W. E. GARNER, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

The packaging system of a cotton gin consists primarily of a press, a tramper, and a pumping unit, each with auxiliaries such as lint kickers and hydraulic piping.

Bale Presses

Bale presses may be described according to their construction material, direction of packing, density of bale, or some other factor.

Construction material.—A 1957 report by the USDA Agricultural Marketing Service showed that 39.1 percent of the presses in the United States were constructed of wood and 60.9 percent were constructed of steel (*15*). The trend has been toward all-steel construction, and wood presses are found today in only a few of the older installations.

Direction of packing.—Presses may also be described as up-packing or down-packing. In 1957 the up-packing press was found in 63.7 percent of the installations, and the down-packing press was found in 36.3 percent of the installations. The up-packing, or two-story press, is more popular in areas where the water table does not make excavation prohibitive for the deep press pit required. This press is somewhat more convenient than the one-story, down-packing press because the charging box is readily accessible from the operating floor level, and repacking bales is more convenient. Furthermore, in the high-capacity operations that are common today, the two-story press saves about 20 seconds as compared with the down-packing, or one-story press, since the bale ties may be inserted in the platen slots as the ram is coming up. On the down-packing press, the ram must complete its stroke and the doors must be open before the bale ties can be inserted through the platen slots. This, however, is not considered a serious drawback to the down-packing press, even in operation at capacities well above 10 bales per hour. A two-story, up-packing press is illustrated in figure 70 and a one-story, down-packing press in figure 71.

Density of bale.—Presses may also be described as low-, standard-, or high-density models, which produce bales with approximately 12, 24, or 36 pounds of cotton per cubic foot, respectively. These densities vary somewhat with different

Figure 65.—Important settings and adjustments for the Murray 80–18.

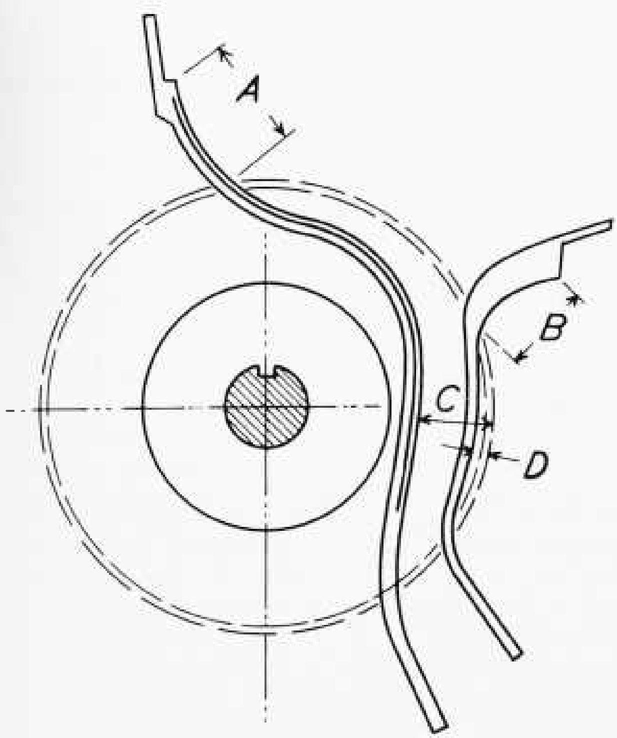


Figure 66.—Critical saw-rib dimensions (A, B, C, and D) vary with manufacturer's make and model. Specifications should be followed for maintaining cotton quality and gin stand capacity.

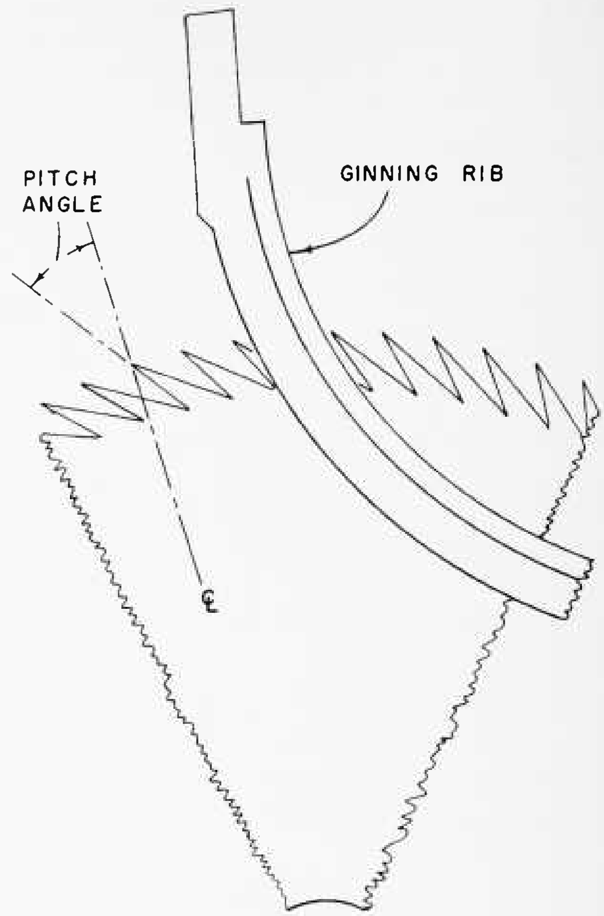


Figure 67.—Leading edge of the tooth should enter the ginning rib parallel to the rib surface, or the point of the tooth should lead the throat slightly. Saws should never be filed or breast adjusted so that the throat leads the point of the tooth. CL=center line.

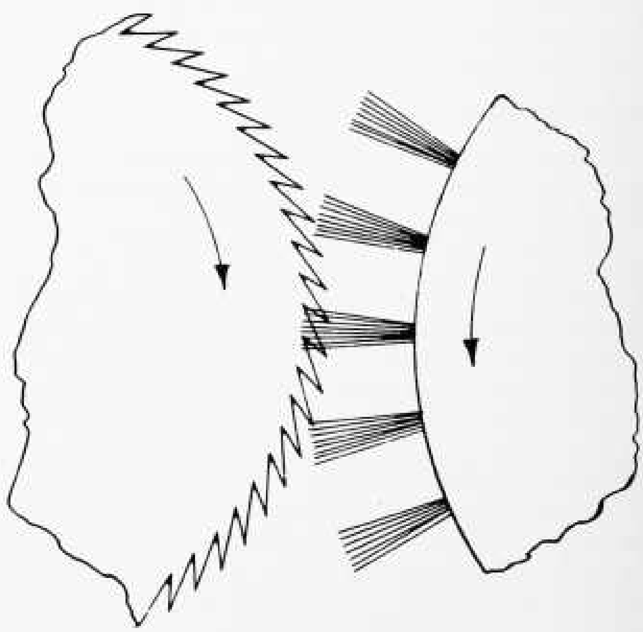


Figure 68.—For proper doffing, the gin brush should be set to mesh with the saw the depth of the saw teeth.

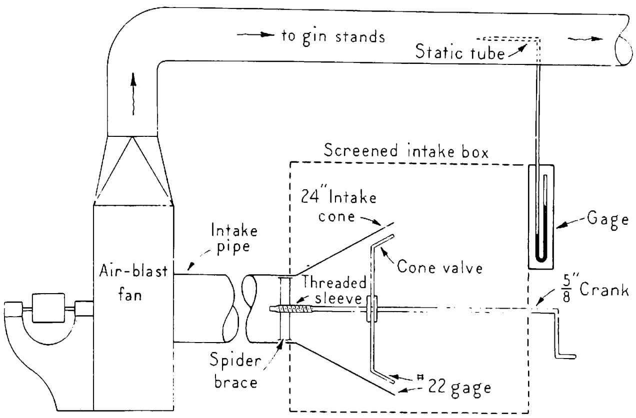


Figure 69.—**Air-blast fan-intake control and gage designed by the USDA Cotton Ginning Research Laboratories.**

manufacturers. Some presses produce bales with densities greater than 40 pounds per cubic foot.

The 1957 report on cotton gin equipment (*15*) showed that low-density or flat bales were produced in 98.4 percent of the gins, and standard-density bales were produced in 1.6 percent of the gins. Since that time, the trend has been toward standard-density gin presses, especially where the bales move over long distances directly to consuming mills. Most of the standard-density and high-density presses are located in the Southwest and the Far West. The regular size of the low-density press boxes is 27 by 54 inches. These presses usually have a single ram approximately 9 inches in diameter. The standard-density and high-density press boxes vary in size according to the manufacturer. Common sizes are 20 by 54 inches, 20 by 50 inches, and 20 by 41 inches, with 1 ram 14 to 17 inches in diameter or 2 or 3 rams approximately 9 inches in diameter. Some standard-density presses are convertible to high density by the addition of one or two rams.

Press operation.—The following procedure is typical of a press without automatic controls, with differences noted for up-packing and down-packing presses:

(1) Before starting the gin plant, be sure that the press circle is locked in position, the doors are locked securely, and bagging has been placed on both follow blocks as well as on the top or bottom of the platen on the baling side of the press.

(2) Push the belt shift lever and start the tramper operating.

(3) Check the press dogs occasionally while ginning the first few bales to see if they are properly adjusted to hold the pressure of the cotton.

(4) When the bale is finished, stop the tramper in the up position just as the follow block clears the press box and before the kicker starts operating. When the tramper is stopped in this position, it is possible to continue ginning while the press is turned. The lint ginned during this period is stored on the lint slide. Release the safety locks and turn the press. With a down-packing press, apply pressure to the ram and raise the follow block, since this raises the press from its cradle and allows the press to be turned.

(5) As soon as the press is locked into its new position, release the tramper belt shift lever and start the tramper operating again.

(6) Start the hydraulic pump.

(7) As determined by the type of press and pump, operate the valves to apply pressure from the pump to the ram. Usually this is done by closing the main operating valve, which starts the ram on its way.

(8) While the ram is coming up, release the bagging from the hooks that hold it on the top platen and expose the tie slots. Push the ties through these slots.

(9) When the follow block reaches the proper level, usually determined by a line on the press box, stop the pump that stops the ram travel.

(10) Release the pressure on the doors of the press by opening with the levers or wheel.

(11) With a down-packing press, place the ties after the press doors have been opened.

(12) Remove the bagging from the follow blocks, push the ties through the slots provided, and tie the bale.

(13) Tuck the excess bagging into the two end ties to form the completed package.

(14) Release the pressure on the ram and pull the bale from the press.

(15) Redress the follow blocks and let the ram return to normal position.

(16) Close the baling doors and secure them in locked position.

(17) Push the press dogs into operating position.

Many improvements and refinements to presses and trampers have been made in recent years. Most have been directed toward speeding up the operation and reducing the manual labor involved and the number of pressmen needed. Presses equipped with devices having varying degrees of automatic, semiautomatic, or electrically controlled components are available.

Quick-acting hydraulic door locks are now common. End doors are available that move in and out automatically when the side doors are closed or open.

Electrical devices are available that automatically control bale weight and density, start and stop the operation, turn the boxes, and provide for the safety of machinery and personnel. Electrical circuits are arranged to control the operation or to suspend automation and permit electrical devices to be operated manually.

Many press installations are designed for push-button control of all the operations except the actual application of the bagging, insertion of ties, and tying out of the bale.

The sequence of operation for pressing and tying out a bale on automatic presses is the same as that described for manually operated presses, even though some steps are performed hydraulically, electrically, or automatically.

Press maintenance.—Maintaining the press is simple, but a regular program of maintenance is essential. Longer, trouble-free operation is obtained when all bolts are kept tight. The press parts are subjected to vibration resulting from the tramper operation, the pump and ram operation, and the expansion and contraction of the cotton.

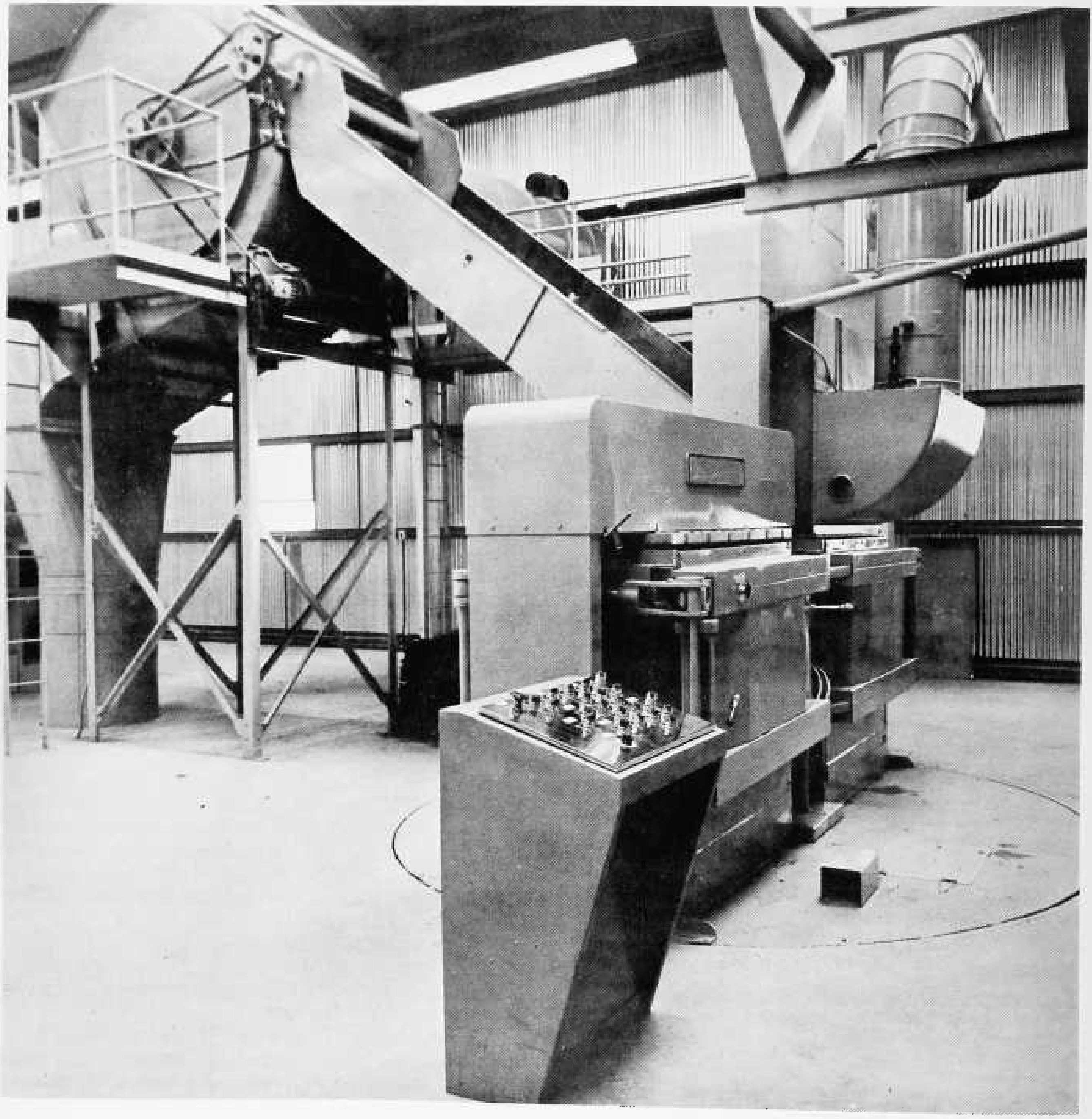


Figure 71.—A one-story, down-packing bale press. This press produces low-density or flat bales. Also shown is a new kicker device for high-capacity operation that uses air suction to move lint from the lint slide into the charging box. A push button control panel is shown in the foreground.

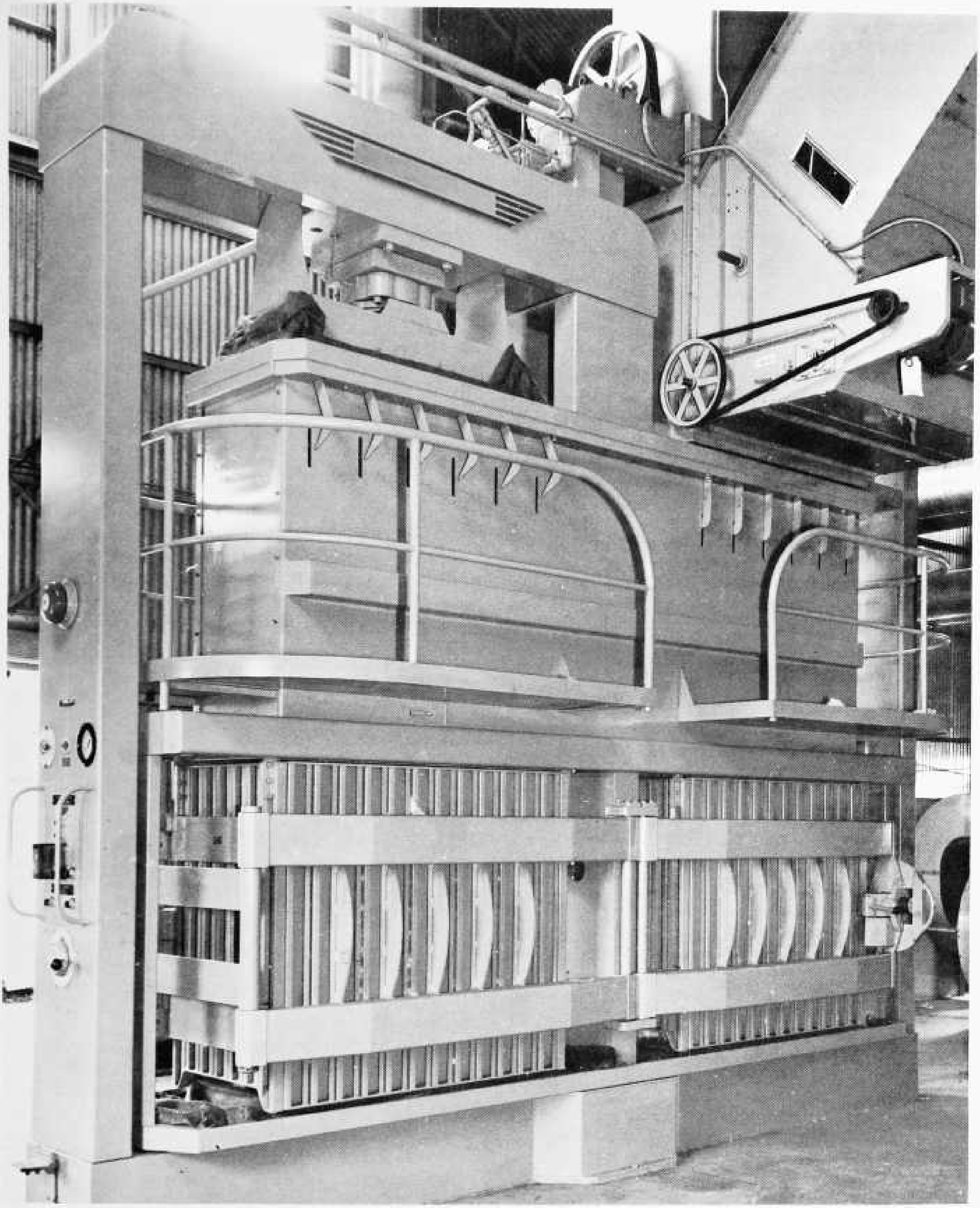


Figure 71.—A one-story, down-packing bale press. This press produces low-density or flat bales. Also shown is a new kicker device for high-capacity operation that feeds lint into the charging box between a powered apron and a powered cylinder, each equipped with gripping lugs.

These actions loosen bolts; therefore, periodically testing the nuts for tightness is an essential part of the maintenance program.

In addition, the ram packing is subjected to continual wear and will require occasional replacement and periodic tightening. The unions in the hydraulic piping should not be permitted to leak, and all items of the electrical control should be maintained in good operating condition at all times.

Press operating difficulties.—If the press is hard to turn, this may be due to several causes. First, the bearings around the central post that holds the frame of the press in alinement may be dry. Second, the two bearing rollers that support the press box under the tramper may not clear the outer rest. If they do not clear the outer rest, the proper adjustment should be made. Third, the ram may not be completely up or down, depending on the direction of the packing. Fourth, the follow block may not have dropped from the top down onto some of the cross members of the press. The press may also be hard to turn because the balls may be locked in the bearings by trash accumulation and the races may be scored.

Ram packing.—The ram or rams sometimes need to have the packing replaced to give proper pressure and to prevent leakage. In replacing the packing, be sure to clean the stuffing box thoroughly. Apply a mixture of graphite and oil to the packing rings. Install one ring at a time, making sure that each ring is in the proper position. Usually these rings have their "V" sections facing the pressure end of the ram. Stagger each joint 90° from the preceding joint. After all rings have been inserted, replace the packing gland. Tighten the cap screws on the packing gland so that the ram will not leak. With a down-packing press, tighten until the ram is held up when pumped to the top. Be sure to tighten all screws evenly to give equal pressure on the packing. With an up-packing press, use only enough pressure on the packing gland to allow the ram to return to its position at the bottom of its stroke.

Other types of ram packing are used, such as those with a "W" or "M" cross section. These can be used in sets of four and are similar to two "V" packings placed side by side. One advantage of these types is that the sealing lips of the packing have a light, uniform pressure against the plunger that is almost independent of the tightening of the packing gland. This enables the packing gland to be tightened snugly against the ram head so there is no leakage, and so the packing does not cause high friction on the ram. This is especially important in the up-packing press with single-acting ram, since the ram is returned to its lower position by its own weight. Excessive packing friction can cause the ram to slow down and even stop in its descent.

Trampers

The purpose of the tramper is to pack the lint into the press box, thus putting it under light compression. A good tramper must combine ruggedness with simplicity. It must be regulated to permit clearing the lint slide between each stroke. Usually a kicker device deposits lint in the press box between strokes of the tramper. The speed of the kicker is related to the time the tramper is up allowing cotton to be "kicked" into the top of the press box.

Trampers are available in several different types, such as the mechanical double-chain and the hydraulic. Regardless of type, care should be taken to prevent contamination of lint beneath the tramper by lubricants or hydraulic fluid that might drip from the tramper mechanism. From 10- to 15-horsepower motors are usually required for trampers.

For high-capacity gins (15 to 20 bales per hour), about 10 strokes per minute for the tramper are recommended. For gins of smaller capacity, the tramper speed should be reduced proportionately. The following data furnished by The Murray Company of Texas, Inc., are typical of speeds and motor sizes for trampers:

Atlas tramper with pusher (a new kicker device)
- 422 r.p.m. (8 strokes) with 5–120 saw outfit requiring 15 hp. motor
- 312 r.p.m. (6 strokes) with 3–120 and 4–120 saw outfits
- 308 r.p.m. with revolving sweep

Heavy duty tramper
- 825 r.p.m. (10 strokes) with 5–120 saw outfit requiring 15 hp. motor
- 635 r.p.m. (8 strokes) with 4–120 saw outfit

Tramper operating problems.—The number of strokes the tramper should run is governed by the rate of ginning for a particular gin. To determine the number, observe the cotton in the lint slide at the end of the bale. If the tramper cleans the slide between each stroke, or if the tramper comes down and the kicker stops, the number of strokes is correct. However, if the storage space is filled between the kicker and the front gate, and the kicker is carrying cotton around between each stroke after the space under the tramper block is filled, add another stroke to the tramper by changing the ratio of the tramper driving and driven pulleys.

Wads of cotton in the ginned sample sometimes result from the condition described above, particularly in tramping large bales. The fact that large bales have wads and small bales do not, indicates that the number of strokes of the tramper should be increased by one. Normally this can be done by increasing the diameter of the pulley 1 inch. However, if this is an odd size that is not readily available, increase the diameter of the pulley 2 inches, since it is better to have one stroke more than is actually needed. The rate of ginning and the number of tramper strokes needed to pack the cotton properly will vary from the normal, or that suggested by the manufacturer.

Kicker speed and new kicker devices.—Most gins use a revolving paddle device to deposit lint from the lint slide into the charging box of the press. This device is usually called a kicker or lint sweep. For press installations operating at capacities greater than 10 bales per hour, some type of high-capacity kicker device is needed.

If the kicker paddle is used, from three to five revolutions of the paddle per stroke of the tramper are recommended, depending on the manufacturer's suggestions and the kicker and tramper design. If three to five revolutions are not enough to deposit the lint into the charging box, the number of strokes of the tramper should be increased by one. It is not advisable to increase the speed of the kicker further if cotton collects around it; but one or more strokes can be added to the tramper, and the amount of storage space for receiving new charges of cotton can thus be increased.

One new kicker device for high-capacity gins (called a lint feeder) consists of a horizontal apron mounted at the bottom of the charging box opening from the lint slide, coupled with a modified kicker paddle or cylinder mounted above the horizontal apron. The apron and the cylinder are provided with lugs or fins about 1 inch high that run the entire width. The lugs provide a gripping action on the lint to propel it into the charging box. Both surfaces are powered, and the top surface of the apron and the bottom surface of the kicker cylinder move toward the charging box with the lint passing between them. The surfaces of the horizontal apron and the kicker cylinder are run at the same peripheral speed. The lint feeder may be driven from the tramper.

Another new kicker device (called a lint pusher) deposits lint into the charging box with a reciprocating action provided by a double-cushioned cylinder. The cylinder is powered by compressed air. This device is synchronized by activation from the foot of the tramper.

A third new kicker device uses air suction to move lint from the lint slide into the charging box. The suction is provided by a motor-driven vane-axial fan. Synchronization is achieved by means of a valve that cuts off the suction on the tramper down stroke and restores it when the follow block clears the inlet opening on the up stroke.

All these devices are intended to deposit lint into the charging box with a fast but gentle action, without agitating, turning, rolling, tumbling, tearing, or otherwise breaking up the batt as it is received from the condenser. If this is accomplished, a smoother lint sample will result.

Tramper lubrication.—The tramper should be kept well lubricated, as suggested by the manufacturer. All bolts and nuts should be kept tight.

Press Pumping Unit

Hydraulic piping.—The hydraulic piping used in press installations is a special, heavy-duty type. One rule of thumb for sizing pipes is that the pipe sizes for the pressure lines should provide oil flow at no more than 15 feet per second velocity. Pipe sizes in the return line in systems where the ram is returned to its lower position by gravity should not allow velocities above 5 feet per second. In some new hydraulic systems, the operating valve is mounted adjacent to the pump, and there is only one hydraulic line from the pump unit to the press ram. Appropriate valves enable this line to serve as both pressure and return, thus eliminating the necessity of having two hydraulic lines from the pump to the press. Such an installation tends to eliminate hydraulic leaks.

Press pumps.—The 1957 survey of gin equipment (*15*) showed that 51.4 percent of the press pump drives were by a separate motor and 48.6 percent were by a countershaft. The form of hydraulic pump used depends largely on the kind of power available. Triplex pumps and new forms of directly connected rotary pumps are popular because they operate smoothly and are free from trouble. Piston pumps may be vertical, horizontal, or V-type and may be provided either with tight and loose pulleys or V-belts, so that they may run steadily or may idle between bale pressings.

It is generally advisable in motor-driven gins to operate the press pump with a separate motor, so that variable peak loads are not imposed on the main motor and power consumption may be reduced when the pump is not needed.

Motors of 15 to 60 horsepower are required for pumps in press installations producing the low-density or flat bale. For standard-density or high-density bales, much larger motors and pumping units are required. A typical standard pumping unit for an up-packing press in a high-capacity operation is driven by a 25-horsepower motor and provides 39 gallons of oil per minute up to a pressure of 2,250 pounds per square inch. The standard ram diameter is 8⅜ inches, but larger rams may be provided. The ram travel time in pressing the bale is 25 seconds. The single-acting ram returns to its lower position by its own weight in 10 seconds.

A pumping unit for standard-density presses is illustrated in figure 72. It consists of a 50-gallon-per-minute vane pump and a 35-gallon-per-minute piston pump.

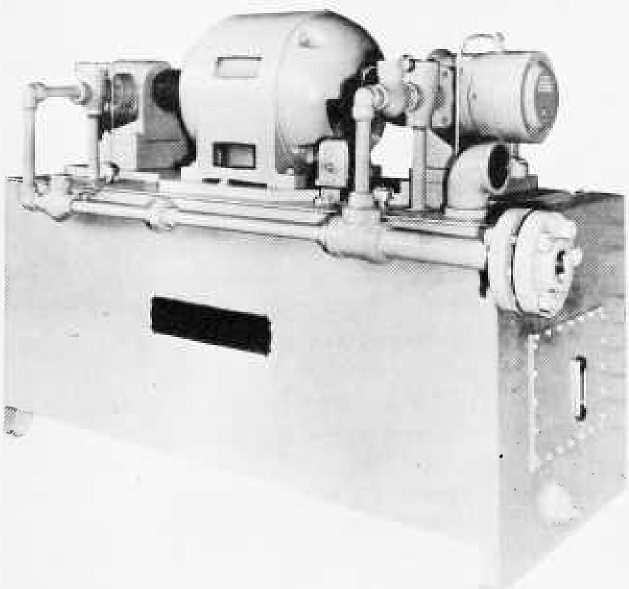


Figure 72.—**A hydraulic pumping unit for standard-density presses.**

Problems in Packaging

Overweight bales.—Methods of packaging cotton at gins sometimes produce irregular and unevenly packed bales. Such bales create problems in transportation, in compressing, and in the cotton mills. Cotton ginners often overlook the importance of producing neat appearing and uniformly packed bales. Overweight bales are hard on the packaging equipment in the local gins and in the various segments of the industry that handle cotton after it leaves the gin. All bales should be made as uniform as possible in weight, within a range of 450 to 550 pounds.

Big-ended bales.—Big-ended bales occur in ginning when more lint is deposited at one end of the press box than at the other. During the pressing operation, the increased density or weight at one end of the bale forces the follow block into an inclined position, thus forming wedge-shaped bales. This condition is illustrated in figure 73. Sometimes the press hands leave slack ties on the light end of the bale. This prevents the uneven weight from being apparent when the bale is released from the press. Some bales appear to be big ended, although they are not unevenly packed. A faulty press, faulty ram packing, or a defective control valve can cause this condition because the ram can slip after the bale is pressed and while the ties are being applied. Between the time the first and last ties are applied, the bale becomes larger at one end than at the other. The dangers of tramper breakage and press distortion are great with uneven bales. A ginner cannot afford to risk a broken ram or sprung center column, particularly when uneven packing can be eliminated.

Lint cotton is conveyed to the condenser from the gin stands or lint cleaners by a continuous air current. Any deviation from uniform flow will automatically disrupt the even flow of the lint cotton. Lint flues in a bent or battered condition can sometimes affect the flow of air, so that lint will not travel through them uniformly.

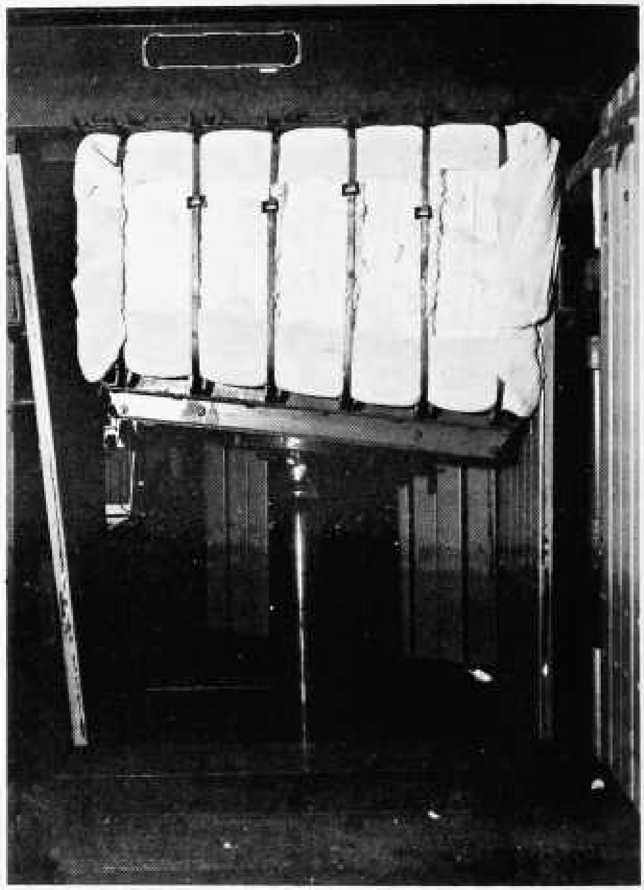


Figure 73.—**A big-ended or heavy-ended bale in a gin press.**

Sheet metal deflectors are used in lint flues to provide uniform distribution of the lint on the condenser drum to prevent or correct big-ended bales. Foreign matter such as tags, rivet heads, rust, or protrusions can often cause deflection of the uniform air current, which results in uneven batts on the screen of the condenser.

Condensers in poor operating condition, flashings in bad condition, and nonuniform drum resistance may cause more cotton and air to be deflected to one end of the drum and thus produce big-ended bales. Daily inspection of the condenser and its vent pipes is a good preventive measure and will reduce the number of big-ended bales.

Rolling bales.—Rolling bales are caused primarily by faulty action of the tramper and kicker device. If the action of the kicker is too strong or not strong enough to kick the lint into the press box, the lint will not be evenly distributed. Proper adjustment of the kicker speed and action is necessary for synchronizing with the tramper and for achieving good results. The speed or rate of sweep is the principal factor affecting the distribution of lint in the press box. If the discharge is too strong, more lint will be deposited in the front of the press box than in the rear. The reverse is true if the discharge is too weak. Variations in tramper speed seem to have little effect on uniformity of bale layering. However, if the kicker is driven from the tramper, a change in tramper speed will affect unevenly packed bales because of the change in kicker speed. Figure 74 shows an end view of a rolling bale.

Sometimes rolling bales are produced when the lint slide is too short or when it has too much slope. The lint slide contour can be adjusted to prevent rolling bales.

With high-density bales, slipping the ties through the buckles will sometimes cause rolling bales. Improved ties and buckles and proper application of the ties to the bale can usually correct this situation.

The ginner, however, is still responsible for making reasonable efforts to have cotton delivered in an even flow into the gin press box.

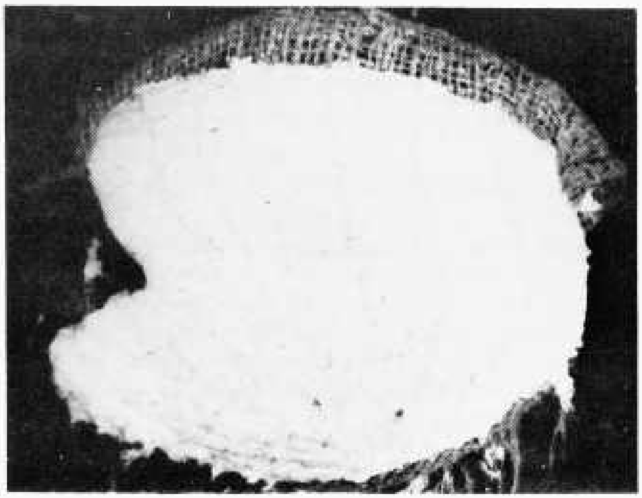


Figure 74.—**End view of a rolling bale.**

Materials Handling

FANS AND PIPING

By V. L. Stedronsky, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Pneumatic systems consume from 40 to 60 percent of the total power required in a modern cotton gin. These systems are used to: (1) Convey seed cotton from truck, trailer, or storage; (2) operate cotton conditioners or driers; (3) supply necessary volumes of air to the doffing nozzles of air-blast gins; (4) convey cotton from point to point in the ginning system; and (5) convey seed, hulls, and trash.

Fans

The heart of the pneumatic systems in gins is the fans. Fans are generally high users of power. Field tests have shown they often use excessive amounts of power, and this increases the cost of the ginning operation. Several types of fans are used, but most are of the centrifugal type. This type of fan has a single inlet and is fully housed in cast iron or sheet metal scrolls in which bladed wheels revolve (fig. 75).

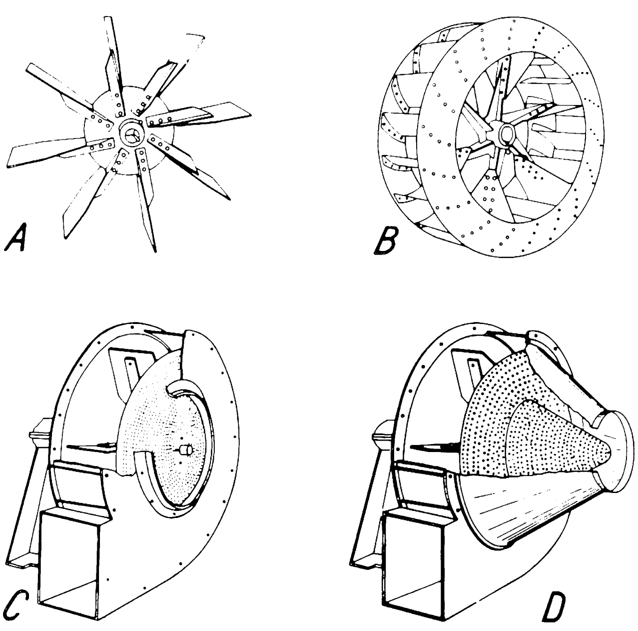


Figure 75.—Representative types of cotton gin fan wheels: *A*, Plain 8-blade wheel; *B*, shrouded 18-blade wheel; *C*, Rembert-type wheel in casing; *D*, Rembert-type cone developed by the USDA Cotton Ginning Laboratories (public patent).

Size designations are confusing because each manufacturer uses his own descriptive terms. Many fans, however, are designated simply by sizes from No. 30 to No. 50, which in general indicates the number of hundreds of cubic feet of air a fan will deliver per minute.

It is important to know the type and diameter of the wheel inside the housing. Outside appearance tells little about the capabilities of a given fan. It is possible to have oversized or undersized wheels in any fan scroll.

Data on fans and fan wheels of different makes and models are shown in table 10.

Rembert fans (fig. 75 *C* and *D*) with perforated flat disks or cones permit the material to pass through the fan scroll without damage from the wheel. These fans are generally used for transferring seed cotton from one location to another without use of a separator, such as from trailer to storage places.

Fans should not be operated at higher speeds than are necessary to function properly. If it becomes necessary to speed up fans, remember the following are basic laws of fan performance:

(1) Volume (c.f.m.) varies directly with the speed (r.p.m.).
(2) Pressure (inches of water) varies as the square of the speed (r.p.m.).
(3) Power (hp.) varies as the cube of the speed (r.p.m.).

These laws are expressed in formulas, as follows:

$$(1)\quad \frac{\text{original volume}}{\text{final volume}} = \frac{\text{original speed}}{\text{final speed}}$$

$$(2)\quad \frac{\text{original pressure}}{\text{final pressure}} = \frac{\text{original speed squared}}{\text{final speed squared}}$$

$$(3)\quad \frac{\text{original horsepower}}{\text{final horsepower}} = \frac{\text{original speed cubed}}{\text{final speed cubed}}$$

Many ginners do not realize what this means to them in power consumption. For example, if the speed of a fan is doubled, the air volume is also doubled; but the resistance pressure is four times greater and the horsepower used is eight times greater.

Again, for example, assume that a fan operating at 1,100 revolutions per minute and delivering 2,500 cubic feet per minute of air against a static pressure of 6 inches of water is using 5 horsepower. With all other conditions remaining the same, the speed is doubled to 2,200 revolutions per minute.

The air volume will be doubled to 5,000 cubic feet per minute, the static pressure will be increased to 24 inches of water resistance, and the power consumed will increase from the initial 5 to 40 horsepower.

Again, assume that a fan is operating at 1,404 revolutions per minute and is consuming 11.7 horsepower and is delivering 3,868 cubic feet per minute with a pressure of 11 inches on the water gage. Speeding up the fan to 1,520 revolutions per minute increases the power consumption to 14.8 horsepower, the pressure to approximately 13 inches, and the volume of air to 4,187 cubic feet per minute.

Piping

For a pneumatic system to be practical, the material must be directed from point to point. In cotton gins it is directed through sheet metal pipes that vary in size and diameter. These pipes are usually from 6 to 18 inches in diameter and are constructed of galvanized iron from No. 24 to No. 18 gage. Good piping systems are an important part of the gin and should be carefully planned and maintained. Some good rules to follow are:

(1) Make the piping as simple and direct as possible, eliminating unnecessary elbows and valves.

(2) Keep all joints airtight and rigid to prevent air leakage. This saves horsepower.

(3) For good suction in a seed cotton pipe, maintain velocities of 4,000 to 7,000 f.p.m. Telescope sizes are usually 12 to 14 inches in diameter, depending on the seed cotton requirements of the ginning system.

(4) For blowing trash, keep the pipe diameter between 8 and 11 inches for trash and between 10 and 13 inches for seed. The velocity in the pipe should be about 4,000 f.p.m. and for seed at least 1 mile a minute (5,280 f.p.m.). This does not apply to small-pipe seed-blowing systems where the velocity is held to approximately 4,250 f.p.m., while the pressure is greatly increased and the volume of air is reduced.

(5) Do not allow piping for cottonseed and seed cotton to slope downward in the direction of flow. Downward slopes may cause chokages.

(6) Allowing 45 cubic feet of air for each pound of material, use unloading and overflow suction piping that will obtain the highest velocity with the required air volume.

(7) Avoid fire hazards in both fan systems. For a cotton house, a Rembert-type fan is simple and economical for handling seed cotton. But a standard fan and separator with correct piping can be employed satisfactorily when used with a belt or screw conveyor in horizontal houses and with a revolving discharge chute into bins of octagonal houses.

(8) For efficiency, maintain a constant speed of the cotton fan. The friction loss in cotton piping from the cotton house to the gin should equal approximately that in the unloading suction line.

To operate efficiently, the pneumatic system must convey the necessary amounts of material and must provide sufficient air to convey the materials satisfactorily. The air velocities required for conveying materials at gins are:

	F.p.m.
Seed cotton	4,000–5,000
Seed cotton in tower drier	1,200–1,400
Bollies in tower drier	1,500–1,600
Dried seed cotton (from machine to machine)	3,000–4,000
Seed	5,000–5,500
Hulls and trash	3,000–4,000
Lint cotton	1,000–1,500

Keep in mind that the flow of air in a pipe in cotton gins is similar to the flow of water in a pipe. Volume, however, is measured in units of cubic feet per minute instead of gallons per minute, as for water. Pressures within the air pipes are measured in units of inches of water measured on a U-tube gage or manometer, rather than in pounds per square inch. Most cotton gin centrifugal fans operate against static pressures or resistances below 27.8 inches of water, which is the equivalent of 1 pound per square inch.

The number, size, and operating rate of gin stands will determine the required rate of flow of seed cotton to the gin (usually from 8 to 15 bales per hour). This flow rate and the layout of the ginning establishment should determine the dimensions and arrangement of the piping. The air pressures needed to overcome the resistance of equipment and pipes and the volume of cotton needed to supply the gins will determine what fan capacity is required.

Air Facts Ginners Should Know

(1) "Static" or resistance pressure in piping systems corresponds to blood pressure in human beings. "Velocity" pressure in piping systems is like the heart beat that causes blood to flow; it conveys the material in a pipe. Static pressure plus velocity pressure make up the total pressure against which a fan must operate.

(2) Few open-wheel cotton gin fans have an efficiency greater than 50 percent. Rembert-type fans, with perforated disks that close the wheel, have approximately 35-percent efficiency.

(3) Where pipe lengths are equal and where equal volumes of air are handled, smaller cotton pipes require more power and cause greater friction resistance or static pressure than do larger pipes (fig. 76).

(4) Power required for suction, air blast, and trash fans should not consume more than ⅜ horsepower per 100 cubic feet of air under average ginning conditions. With cotton gin fans, engi-

TABLE 10.—*Data on fans and fan*

Make and size of fan	Fan wheel					Fan	
	Diameter		Number and types of blades	Blade width	Normal speeds	Height	Width
	Air [1]	Materials handling					
	In.	*In.*		*In.*	*R.p.m.*	*In.*	*In.*
Boardman Superblast:							
30	----	32	8	4		44	33 5/8
35	----	32	8	6		44	35 5/8
40	----	32	8	8	1,500–1,800	44	37 5/8
45	----	32	8	10		44	39 5/8
50	----	32	8	12		44	41 5/8
Continental:							
No. 9	----	16 1/8	[2] 8	6 3/4	1,850	27 3/8	7 1/4
No. 20	----	18.0	[2] 8	7 1/2	2,400	30 3/8	----
No. 30	20 1/2 x 5	20 7/16	[2] 8	8 3/8	2,300	34 3/4	31.0
No. 35	23 3/8 x 5 3/4	23 1/16	[2] 8	10.0	1,950	39 15/16	34 3/8
No. 40	27.0 x 6 3/8	26 11/16	[2] 8	11 3/8	1,750	44 9/16	39 1/2
No. 45	30.0 x 7 3/8	29 7/8	[2] 8	13.0	----	49 3/16	41 11/16
No. 50	33 3/4 x 9 1/8	33.0	[2] 8	15.0	----	54 5/8	43 3/8
Special DFB	----	19.0	[2] 8	6 1/2	2,000	----	----
Hardwicke-Etter:							
25 inches	----	----	----	----	2,500	29 1/16	24 11/16
30 inches	----	24	8	7 3/8	2,520	36 13/16	35 13/16
35 inches	----	28 1/4	8	8 9/16	2,100	42 7/16	37 7/8
40 inches	----	32 1/2	8	9 5/8	1,950	48 1/16	42 1/16
45 inches	----	36 3/4	8	10 3/16	1,850	53 13/16	46 11/16
50 inches	----	41	8	12	1,850	59 1/2	50 13/16
70 inches	----	----	----	----	1,060	77 13/16	59 11/16
Lummus:							
F–76	----	13	[2] 6	5 1/2	3,600	22 3/8	24 9/16
F–96	----	16	[2] 6	6 1/2	2,875	25 13/16	25 9/16
F–116	----	19	[2] 6	7 1/2	2,700	29 3/4	26 9/16
F–136	----	22	[2] 6	8.0	2,250	34 1/2	29 5/16
F–156	----	26	[2] 6	9 1/4	2,000	40 1/4	33 9/16
F–176	----	32	[2] 6	9 5/8	1,800	50 3/8	38 7/16
F–196	----	32	[2] 6	12.0	1,800	50 3/8	40 3/4
Moss-Gordin:							
ASFA–40	----	22	[2] 6	6 1/4	1,450–1,750	31 3/8	24.0
35–40	----	28	[2] 6	10 1/2	1,760–1,970	46 7/8	41 7/16
45–50	31	----	[2] 6	14 13/16	1,860–1,970	52 1/4	46 1/8
Murray:							
2A	----	10 1/2	[2] 6	----		16 7/16	20 5/8
3A	----	12 1/2	[2] 6	----		20 5/16	23 9/16
25	----	19.0	[2] 6	----	1,750–2,100	33 3/4	32 5/16
30	----	19.0	[2] 6	----		33 3/4	32.0
35	----	22 1/2	[2] 6	----		39.0	37.0
Murray:							
30	20 1/2	----	Multi	[3] 7 13/16		33 3/4	32.0
35	27	----	8	8 3/4		39.0	37.0
40	30 1/2	----	8	9 3/4	1,750–2,100	43 5/16	39 3/16
45	33	----	8	10 1/2		47 9/16	43 3/8
50	37	----	10	12		53 1/2	50 5/8

[1] Suction, air blast, and hot air.
[2] Straight.
[3] Tapered.

wheels by make and model

dimensions		Remarks	
Diameter, inlet size	Outlet size (inches)	Fan wheel	Housing
In.			
18 1/16	14 1/8 x 7 1/8	Removable blades, bolted to steel hub	All steel, rectangular. Fan sizes can be increased by changing removable scroll and making fan wider.
18 1/16	14 1/8 x 9 1/8		
18 1/16	14 1/8 x 11 1/8		
18 1/16	14 1/8 x 13 1/8		
18 1/16	14 1/8 x 15 1/8		
----------	8 3/8 (dia.)	Trash wheels have blades bolted to round central disk.	Cast iron, round.
----------	10 (dia.)	----------	
12 7/8	11 (dia.)	----------	
14 11/16	12 (dia.)	----------	
16 7/8	13 (dia.)	Air wheels are multiblade	
18 7/8	14 (dia.)	----------	
20 7/8	15 (dia.)	----------	
----------	10 1/2 x 9	Blades are welded to flat round back plate; same diameter as wheel	Steel plate, flat.
12	9 1/8 x 11 3/4	----------	Cast iron.
12 3/4	9 7/8 x 11 7/8	Steel welded, curved back	All steel, dual-purpose materials handling and air fan.
14 7/8	11 1/2 x 13 7/8	do	
17	13 1/8 x 15 7/8	29-in. diameter wheel when used for air blast fan	
19 1/8	14 3/4 x 17 7/8	----------	
21 1/4	16 3/8 x 19 7/8	----------	
28	25 x 25	----------	
7	6 1/8 x 7 3/4	F–Series are dual purpose for trash and air. Curved blades available for F–176 and F–196 only.	Steel plate, rectangular. Cast iron available for F–516 and F–176.
9	7 1/8 x 9 3/4		
11	9 1/8 x 11 3/4		
13	9 1/8 x 13 3/4		
15	10 5/8 x 15 3/4		
17	11 1/2 x 16 7/8		
19	13 7/8 x 16 7/8		
13	11 1/2 x 8	Blades and hub assembly fastened to round back plate, 20-inch diameter.	Steel plate, rectangular.
17 1/4	14 3/16 x 14 3/4	Straight paddle wheel	Do.
19 1/4	16 9/16 x 16 11/16	do	Do.
6	6 (dia.)	Straight blade	Cast iron, round.
7	7 (dia.)		
13	10 1/2 (dia.)		
13	10 1/2 (dia.)		
15	11 1/2 (dia.)		
13	10 1/2 (dia.)	Multiblade	Do.
15	11 1/2 (dia.)		
17	12 1/2 (dia.)		
19	14 1/2 (dia.)		
21	15 1/2 (dia.)		

neers allow about 44 cubic feet of air at 4,400 feet per minute speed to handle 1 pound of seed cotton.

(5) Piping velocities for handling dry seed cotton should be held below 4,500 feet per minute to avoid cracking or shattering seed where the material hits fan disks, sharp-turn elbows, separator reels, and other objects.

(6) Air volume calculations should include leakage as well as volume in pipes. For example, up to 30-percent leakage in the vacuum wheel of the separator must be allowed for at the fan. Tower driers also frequently leak at defective points, and stopping air leaks often saves money for gin owners.

(7) Fan speeds should be checked and controlled for efficient operation. For each 100 revolutions above 1,750 revolutions per minute, power consumption will increase 20 percent. But volume increases only 5¾ percent for each additional 100 revolutions above 1,750 revolutions per minute.

(8) Normal operating speeds vary usually from 1,400 revolutions per minute to 2,200 revolutions per minute, but for safety they should not have tip speeds of more than 15,000 feet per minute. Forward-pitch fan wheels (fig. 76) are sensitive to speed changes and therefore usually waste more power in gins than do straight-blade wheels. Dampers should be provided on the intakes of all fans that do not handle material through the wheels (fig. 69).

By the use of slide or other good dampers on fan intakes, a substantial saving in power consumption is often possible. Cutting holes in pipes to relieve pressures or to increase air volumes is usually unsatisfactory.

Large-diameter fan wheels at low speeds are generally more efficient than are small-diameter fan wheels at high speeds. Since cotton gin fan

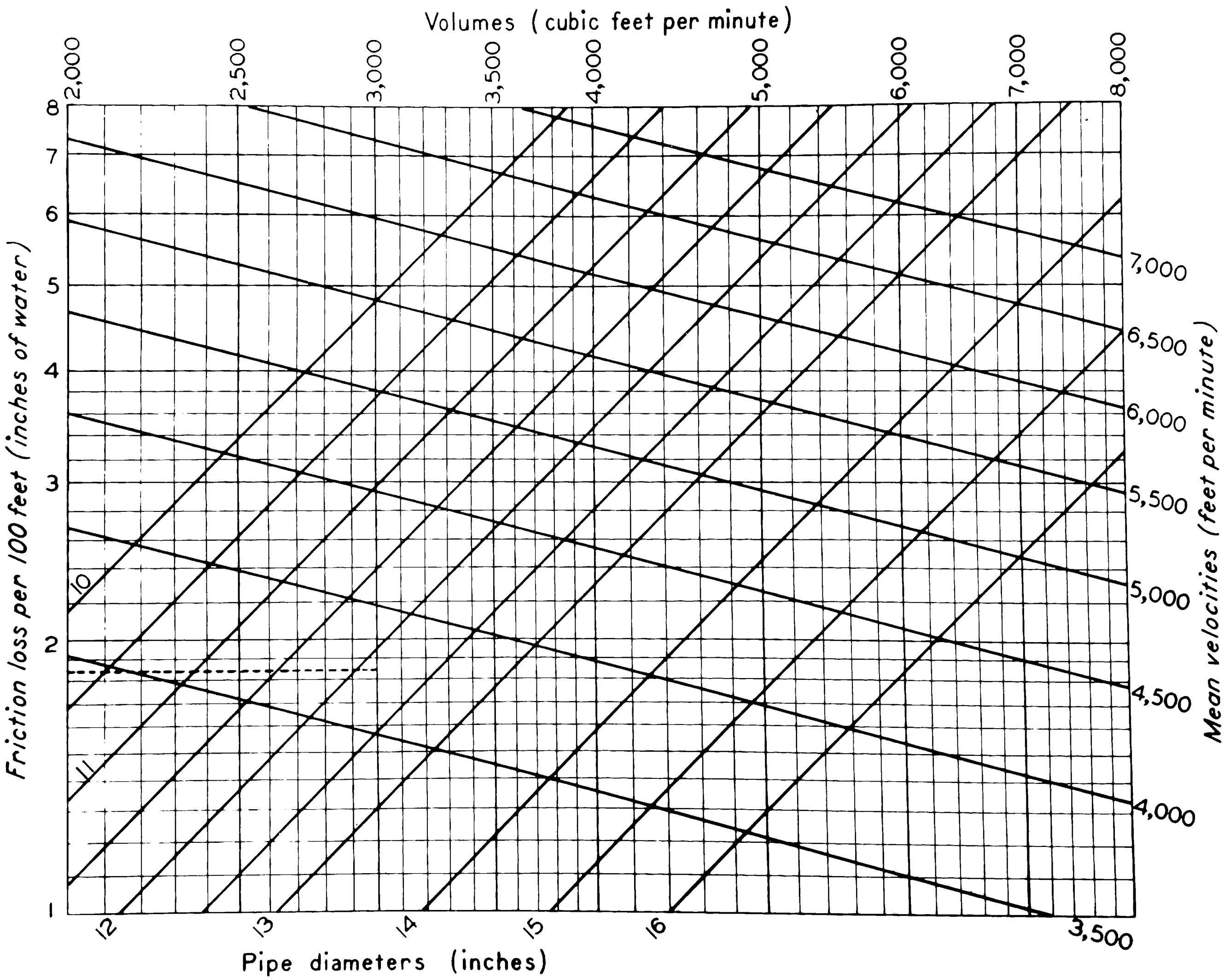


Figure 76.—**Cotton piping chart, giving friction losses in inches of water per hundred feet of piping for different pipe diameters, air volumes, and air velocities.**

casings have a large clearance, it is possible to adapt three sizes of wheels to the fan; namely, an oversized, a standard, or an undersized wheel. Thus the ginner with a No. 40 fan can convert it to a No. 35 or No. 45 fan by changing the wheel. The true size of any fan, then, is the size of its wheel.

Air Measurements

Outside appearances of fans are deceiving. Even when speeds, wheel diameter, and other factors are known, it is difficult to accurately predict fan performance. The only way to determine how a fan is performing and to determine a system's characteristics is by making air readings. Pneumatic systems in gins vary greatly, and no two installations are identical. However, cotton ginners can make the necessary determinations if they have a relatively simple kit of tools and instruments containing the following items:

(1) One one-half-inch drill and round file for making smooth holes in pipes.

(2) One roll of three-fourth-inch gummed paper or tape to close the hole after use.

(3) One 18-inch length of one-fourth-inch copper tubing, bent and finished as shown in figure 77.

(4) Five feet of heavy rubber tubing to fit the copper tube.

(5) One glass U-tube, 18 inches long (fig. 77).

(6) Speed indicator for measuring fan speeds.

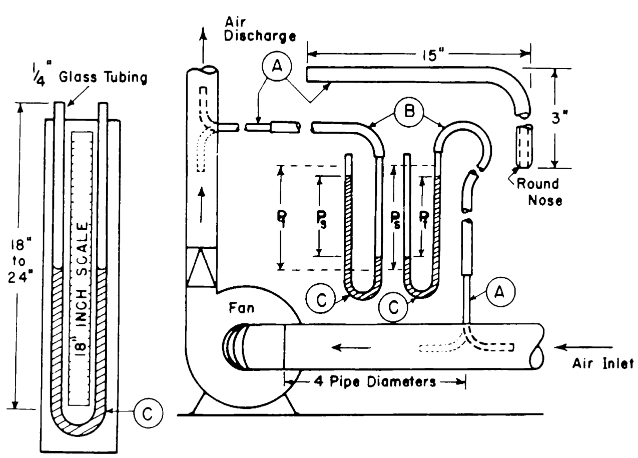


Figure 77.—**Method of testing fan suction and discharge of piping.**

To use a test kit for finding the volumes, velocities, pressures, and horsepower in a piping system, readings must be taken at the fan inlet and discharge. Since a fan may be used either for suction or for blowing through pipes, the static readings are taken at both the fan inlet and the fan outlet to find the overall static pressure. The outlet reading is all that is necessary on a fan that is used only for blowing. Other readings may also be taken where information is needed, such as at troublesome points in suction, drying, and air-blast piping systems, and at separator inlets and outlets to determine leakage. Test holes should be downstream from elbows and valves by a distance of at least four pipe diameters. The inside of these test holes must be smooth to prevent air eddies and deflection of flow. Gin fans usually operate at static pressures ranging from 5 to 20 inches of water as measured on a **U**-tube gage. The following directions for using the test kit may be helpful:

(1) Fill the **U**-gage E (fig. 77) half full of clear or colored water, as desired. Connect the rubber hose *D* to the copper tube *C*, and hold the **U**-gage vertical during all readings.

(2) Insert the bent end of the copper tube *C* in the test hole far enough to reach the center of the pipe (fig. 77) with the stem of the tube at 90° to the pipe, and with the nose of the tube pointing upstream into the air current, parallel to the pipe. Measure the differences in water levels between the two legs or columns of the gage. This reading is the total or impact pressure. Because the water column levels usually fluctuate, use the differences between the average high and the average low.

(3) Reverse the tube to point downstream, holding the stem of the tube at right angles to the pipe. Read the gage again for the static pressure. This reading may be checked by withdrawing the tube and holding the end of the rubber hose over the test hole in the pipe. Both static pressure readings should be alike in value. Repeat the process, and take the static pressure reading on the discharge side of the fan. The static pressure reading on the discharge side will be needed later for determining the horsepower.

The difference between the total or impact pressure and the static pressure is the velocity pressure. In most cases, the Pv (velocity pressure) readings will range from ½ to 3 inches, water gage. After the Pv reading has been obtained, the velocity of the air and the volume of air the fan is delivering can be obtained from the data in table 11. The left-hand column of table 11 gives Pv pressures, the second column the square root of the Pv pressure ($\sqrt{Pv}$), and the third column the velocity (f.p.m.) that corresponds to the Pv pressures. The body of the table gives the volume (c.f.m.) for any given Pv reading and pipe size.

For example, assume a Pv reading of 1.6 inches of water in a 13-inch-diameter round pipe; from table 11 we find that the cross-sectional area is 0.9218 square feet, the velocity is 4,599 f.p.m., and the volume is 4,240 c.f.m.

TABLE 11.—*Velocities and volumes of water for various Pv readings and pipe diameters* [1]

Pv (inches of water)	√Pv	Velocity	Cross-sectional area in square feet and pipe diameter in inches [2]														
			0. 4418	0. 4922	0. 5454	0. 6013	0. 6600	0. 7215	0. 7854	0. 8522	0. 9218	0. 9940	1. 069	1. 147	1. 227	1. 396	1. 576
			9	9½	10	10½	11	11½	12	12½	13	13½	14	14½	15	16	17
		F.p.m.	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*	*C.f.m.*
0. 1	0. 32	1, 168	516	575	637	702	771	842	917	995	1, 077	1, 161	1, 249	1, 340	1, 433	1, 630	1, 841
. 2	. 45	1, 642	725	808	895	987	1, 084	1, 185	1, 290	1, 400	1, 514	1, 633	1, 756	1, 884	2, 016	2, 293	2, 588
. 3	. 55	2, 008	887	988	1, 095	1, 207	1, 325	1, 448	1, 577	1, 710	1, 851	1, 995	2, 146	2, 302	2, 463	2, 802	3, 164
. 4	. 63	2, 300	1, 016	1, 132	1, 254	1, 383	1, 518	1, 659	1, 806	1, 959	2, 120	2, 286	2, 458	2, 637	2, 822	3, 210	3, 624
. 5	. 71	2, 592	1, 144	1, 276	1, 414	1, 559	1, 710	1, 869	2, 036	2, 208	2, 389	2, 576	2, 770	2, 972	3, 180	3, 618	4, 084
. 6	. 77	2, 810	1, 241	1, 383	1, 533	1, 690	1, 855	2, 027	2, 208	2, 395	2, 591	2, 794	3, 004	3, 223	3, 448	3, 923	4, 429
. 7	. 84	3, 066	1, 354	1, 509	1, 672	1, 844	2, 024	2, 212	2, 408	2, 612	2, 827	3, 048	3, 278	3, 516	3, 762	4, 280	4, 832
. 8	. 89	3, 248	1, 435	1, 599	1, 772	1, 953	2, 144	2, 343	2, 552	2, 768	2, 995	3, 229	3, 473	3, 725	3, 986	4, 534	5, 119
. 9	. 95	3, 467	1, 531	1, 706	1, 891	2, 085	2, 289	2, 501	2, 724	2, 954	3, 197	3, 447	3, 707	3, 977	4, 255	4, 840	5, 464
1. 0	1. 00	3, 650	1, 612	1, 797	1, 991	2, 195	2, 409	2, 633	2, 867	3, 110	3, 365	3, 628	3, 902	4, 186	4, 479	5, 095	5, 752
1. 1	1. 05	3, 832	1, 693	1, 886	2, 091	2, 304	2, 529	2, 765	3, 010	3, 265	3, 533	3, 809	4, 097	4, 395	4, 703	5, 350	6, 039
1. 2	1. 10	4, 015	1, 773	1, 976	2, 170	2, 414	2, 650	2, 896	3, 154	3, 421	3, 701	3, 991	4, 292	4, 605	4, 927	5, 604	6, 328
1. 3	1. 14	4, 161	1, 838	2, 048	2, 270	2, 502	2, 746	3, 002	3, 268	3, 545	3, 836	4, 136	4, 448	4, 772	5, 106	5, 808	6, 558
1. 4	1. 18	4, 307	1, 902	2, 120	2, 349	2, 590	2, 843	3, 111	3, 383	3, 670	3, 971	4, 281	4, 604	4, 939	5, 285	6, 012	6, 788
1. 5	1. 22	4, 453	1, 967	2, 192	2, 429	2, 678	2, 939	3, 212	3, 498	3, 794	4, 105	4, 426	4, 760	5, 107	5, 464	6, 215	7, 018
1. 6	1. 26	4, 599	2, 031	2, 264	2, 508	2, 765	3, 035	3, 318	3, 612	3, 919	4, 240	4, 571	4, 916	5, 274	5, 644	6, 420	7, 248
1. 7	1. 30	4, 745	2, 096	2, 335	2, 588	2, 853	3, 132	3, 423	3, 727	4, 043	4, 374	4, 716	5, 073	5, 442	5, 823	6, 623	7, 478
1. 8	1. 34	4, 891	2, 160	2, 407	2, 668	2, 941	3, 228	3, 528	3, 842	4, 167	4, 509	4, 862	5, 229	5, 609	6, 002	6, 827	7, 708
1. 9	1. 38	5, 037	2, 225	2, 479	2, 748	3, 029	3, 324	3, 634	3, 956	4, 292	4, 644	5, 007	5, 385	5, 777	6, 181	7, 031	7, 938
2. 0	1. 41	5, 146	2, 273	2, 533	2, 807	3, 094	3, 397	3, 713	4, 042	4, 385	4, 745	5, 115	5, 502	5, 902	6, 315	7, 184	8, 110
2. 1	1. 45	5, 292	2, 337	2, 605	2, 887	3, 182	3, 493	3, 818	4, 157	4, 509	4, 879	5, 261	5, 658	6, 070	6, 495	7, 388	8, 340
2. 2	1. 48	5, 402	2, 386	2, 659	2, 947	3, 248	3, 565	3, 897	4, 243	4, 603	4, 980	5, 369	5, 775	6, 195	6, 629	7, 541	8, 514
2. 3	1. 52	5, 548	2, 450	2, 731	3, 026	3, 336	3, 662	4, 002	4, 358	4, 727	5, 114	5, 515	5, 931	6, 363	6, 808	7, 744	8, 744
2. 4	1. 55	5, 658	2, 499	2, 785	3, 086	3, 402	3, 734	4, 081	4, 444	4, 820	5, 216	5, 623	6, 048	6, 488	6, 942	7, 897	8, 917
2. 5	1. 58	5, 767	2, 547	2, 839	3, 146	3, 468	3, 806	4, 160	4, 530	4, 914	5, 317	5, 732	6, 165	6, 614	7, 077	8, 050	9, 089
2. 6	1. 61	5, 876	2, 596	2, 892	3, 205	3, 533	3, 878	4, 240	4, 615	5, 008	5, 416	5, 841	6, 281	6, 740	7, 210	8, 203	9, 260
2. 7	1. 64	5, 986	2, 644	2, 946	3, 265	3, 599	3, 951	4, 319	4, 701	5, 101	5, 518	5, 950	6, 399	6, 866	7, 345	8, 356	9, 434
2. 8	1. 67	6, 096	2, 693	3, 000	3, 325	3, 666	4, 023	4, 398	4, 788	5, 195	5, 619	6, 059	6, 517	6, 992	7, 480	8, 510	9, 607
2. 9	1. 70	6, 205	2, 741	3, 054	3, 384	3, 731	4, 095	4, 477	4, 873	5, 288	5, 720	6, 168	6, 633	7, 117	7, 614	8, 662	9, 779
3. 0	1. 73	6, 314	2, 790	3, 108	3, 443	3, 797	4, 167	4, 556	4, 959	5, 381	5, 820	6, 276	6, 750	7, 242	7, 747	8, 814	9, 951

[1] Velocity $= 3{,}650 \sqrt{Pv}$; volume $=$ velocity x cross-sectional area of pipe.
[2] Cross-sectional area of 6 inches=0.1964; 8 inches=0.3491; 8½ inches=0.3941; 18 inches=1.767; 19 inches=1.969; 20 inches=2.182.

After determining the volume (c.f.m.) of air the fan is moving and the resistance (static) pressures the fan is operating against, the ginner can determine from table 12 the horsepower of the fan. If fans must draw air through suction piping and must blow it out the discharge piping, the static pressures of both must be known. The sum of the static pressures of the suction and discharge pipe plus the velocity pressure readings is the total pressure shown in table 12. In most gins, the suction and discharge static pressure readings added together will usually range from 10 to 16 inches on the water gage.

For example, the impact reading Pt (total pressure) shows 10.6 inches on the water gage on a 16-inch-diameter inlet of a cotton suction fan with the tube pointing *into the flow* of air. With the tube pointing *with the flow* of air, the static reading Ps (static pressure) is 12 inches. The difference, velocity pressure Pv, is 1.4 inches. In table 11, a Pv of 1.4 gives a velocity of 4,307 feet per minute and a volume of 6,012 cubic feet per minute of air in the 16-inch pipe. On the discharge pipe of the fan, the static pressure Ps with the tube pointing with the flow of air is 5 inches. Adding the two static pressures gives 17 inches. This represents the overall static pressure across the fan, but the Pv of 1.4 inches must be added to this to get total pressure or total resistance against which the fan is laboring, or a Pt of 18.4 inches.

TABLE 12.—*Approximate average horsepower required for a fan operating under specified conditions* [1]

Volume of air handled by fan (c.f.m.)	Total pressure (inches) against which fan is operating									
	11	12	13	14	15	16	17	18	19	20
	Hp.	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
3,000	10. 8	11. 4	12. 3	13. 2	14. 2	15. 1	16. 1	17. 0	18. 0	18. 9
3,500	12. 1	13. 2	14. 3	15. 4	16. 5	17. 7	18. 7	19. 8	20. 9	22. 0
4,000	13. 9	15. 1	16. 4	17. 6	18. 9	20. 1	21. 4	22. 6	23. 9	25. 2
4,500	15. 6	17. 0	18. 4	19. 8	21. 2	22. 6	24. 1	25. 5	26. 9	28. 4
5,000	17. 3	18. 9	20. 5	22. 1	23. 6	25. 2	26. 8	27. 4	29. 9	31. 5
5,500	19. 1	20. 8	22. 5	24. 2	26. 0	27. 7	29. 4	31. 3	32. 9	34. 6
6,000	20. 8	22. 7	24. 6	26. 5	28. 4	30. 2	32. 1	34. 0	35. 9	37. 8
6,500	22. 6	24. 6	26. 6	28. 7	30. 7	32. 8	34. 8	36. 8	38. 9	40. 9
7,000	24. 3	26. 5	28. 7	30. 9	33. 1	35. 3	37. 5	39. 7	42. 0	44. 2

[1] Horsepower is for sea level reading. Add 0.4 percent to the horsepower in the table for each 500 feet of elevation above sea level.

From table 12 we find that a fan moving 6,000 cubic feet per minute against an overall resistance of 18 inches is using 34 hp. Interpolating for the 0.4 Pt, we find that the power consumed is 34.75 hp.

A ginner can make power determination on any fan by using the data in tables 11 and 12. However, for obtaining the fan power consumption he may do so by the use of mathematical formulas. Using the same air reading as in the previous example, the horsepower can be calculated by the following procedure:

Pt (impact) fan inlet	10.6 inches water
Ps (static) fan inlet	12.0 inches water
Pv (velocity) fan inlet	1.4 inches water
Ps (static) fan outlet	5.0 inches water

Ps across fan 12+5 (17.0 inches water)
Pt across fan 17.0+1.4 (18.4 inches water)

$$\text{Area 16-inch pipe}=\frac{\pi D^2}{4}$$

$$A=\frac{3.1416\times(16)^2}{4}$$

$$A=\frac{3.1416\times 256}{4}$$

$$A=201.06 \text{ square inches}$$

$$A=\frac{201.06}{144}=1.396 \text{ square feet}$$

$$\text{Velocity}=3{,}650\sqrt{\text{Pv}}$$

$$=3{,}650\sqrt{1.4}$$

$$=3{,}650\times 1.18$$

$$=4{,}307 \text{ f.p.m.}$$

(*Note:* The constant 3,650 is for use with single reading in center of round pipe at sea level. Add 35 to 3,650 for each 500 feet of elevation above sea level.)

Volume=velocity×cross-sectional area of pipe in square feet
Volume=4,307×1.396
Volume=6,012 c.f.m.

Theoretical air horsepower is:

$$\text{Air hp.} = \frac{\text{volume} \times \text{Pt}}{6{,}356}$$

$$= \frac{6{,}012 \times 18.4}{6{,}356}$$

$$= 0.9459 \times 18.4$$

$$= 17.4 \text{ hp.}$$

Assume a fan efficiency of 50 percent. Actual horsepower $= \frac{\text{Air hp.}}{\text{efficiency}}$.

$$\text{Actual horsepower} = \frac{17.4}{.50} = 34.8 \text{ hp.}$$

(*Note:* The calculations in this example disregard some minor corrections such as those for standard air, altitudes, barometric pressure, air temperature rise in fans, and a more complicated procedure of obtaining Pt; but the results are sufficiently accurate for gin house work.)

MECHANICAL CONVEYORS

By D. M. ALBERSON, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Several types of mechanical conveyors are used in cotton gins. These conveyors may be classified as (1) belt conveyors, (2) screw conveyors, and (3) chain conveyors.

Belt conveyors, although formerly used in seed cotton distributors, are primarily used at present only for conveying cottonseed from under the gin stands to a dropper discharging into a pneumatic small-pipe seed-conveying line. The principal advantage of using the belt conveyor under the gin stands is that it is self-cleaning. In installations ginning cotton for planting-seed, use of the belt conveyor enables the ginner to maintain pure seed without a great amount of cleaning. The belt conveyor is efficient, requires relatively small horsepower, and has a high carrying capacity. A properly designed belt system has a long service life; however, the initial cost is usually high. Installation is recommended where amortization of this high initial cost is assured through reduced cleaning costs or for other reasons. Seed belt conveyor capacities are flexible because of the relatively high belt speeds permissible. An 8-inch seed belt running at a speed of 100 feet per minute in a 6-inch-deep trough will handle over 18 tons of seed per hour at 75-percent capacity.

Screw conveyors and screw lifts are the most common mechanical handling devices used in cotton ginning. They are used to convey cottonseed, gin trash, and seed cotton. Screw conveyors are simple and relatively inexpensive but require more power than do belt conveyors. The standard pitch screw has a pitch approximately equal to the diameter and is used on most horizontal installations and on inclines up to 20°. Horizontal screw conveyors are usually operated in a **U**-shaped trough with the screw supported at various standard spacings. Screw elevators are enclosed in cylindrical housings. The tube is operated full with no brackets used between ends. Screw elevators are normally used in the gin only in conveying cottonseed. Concise formulas and data are not available for individual designs; however, empirical equations given below can be used.

$$\text{Cubic feet per hour} = \frac{(D^2 - d^2)}{36.6} \times P \times \text{r.p.m.}$$

where D = screw diameter (inch)
d = shaft diameter (inch)
P = screw pitch (inch)—normally equal to D
r.p.m. = revolutions per minute of shaft

The actual capacity will be much less than the theoretical because of screw-housing clearance, fluid characteristics of material, screw length, head of material, and lift. When specific operating data are not available, an estimate of 50 to 60 percent of the theoretical capacity is advisable.

The power requirement of a screw conveyor is a function of its length, elevation, type of hangers, type of flights, internal resistance or viscosity of the material, coefficient of friction of the material on the flights and housing, and weight of the material. Consideration should also be given to the extra power required to start a full screw and to free a jammed screw. An approximation of the power required to operate a normal horizontal screw can be determined by the following equation:

Horsepower = CLWF/33,000
where C = conveyor capacity (c.f.m.)
L = length of conveyor (ft.)
W = bulk material weight (lbs. per cu. ft.)
Cottonseed = 25–30 lbs. per cu. ft.; average trash wt. = 10–12 lbs. per cu. ft.; seed cotton = 4–6 lbs. per cu. ft.
F = material factor (cottonseed = 0.9 and gin trash 0.9)

Screw conveyor size, capacity, and recommended speeds for normal gin operations are given in figure 78.

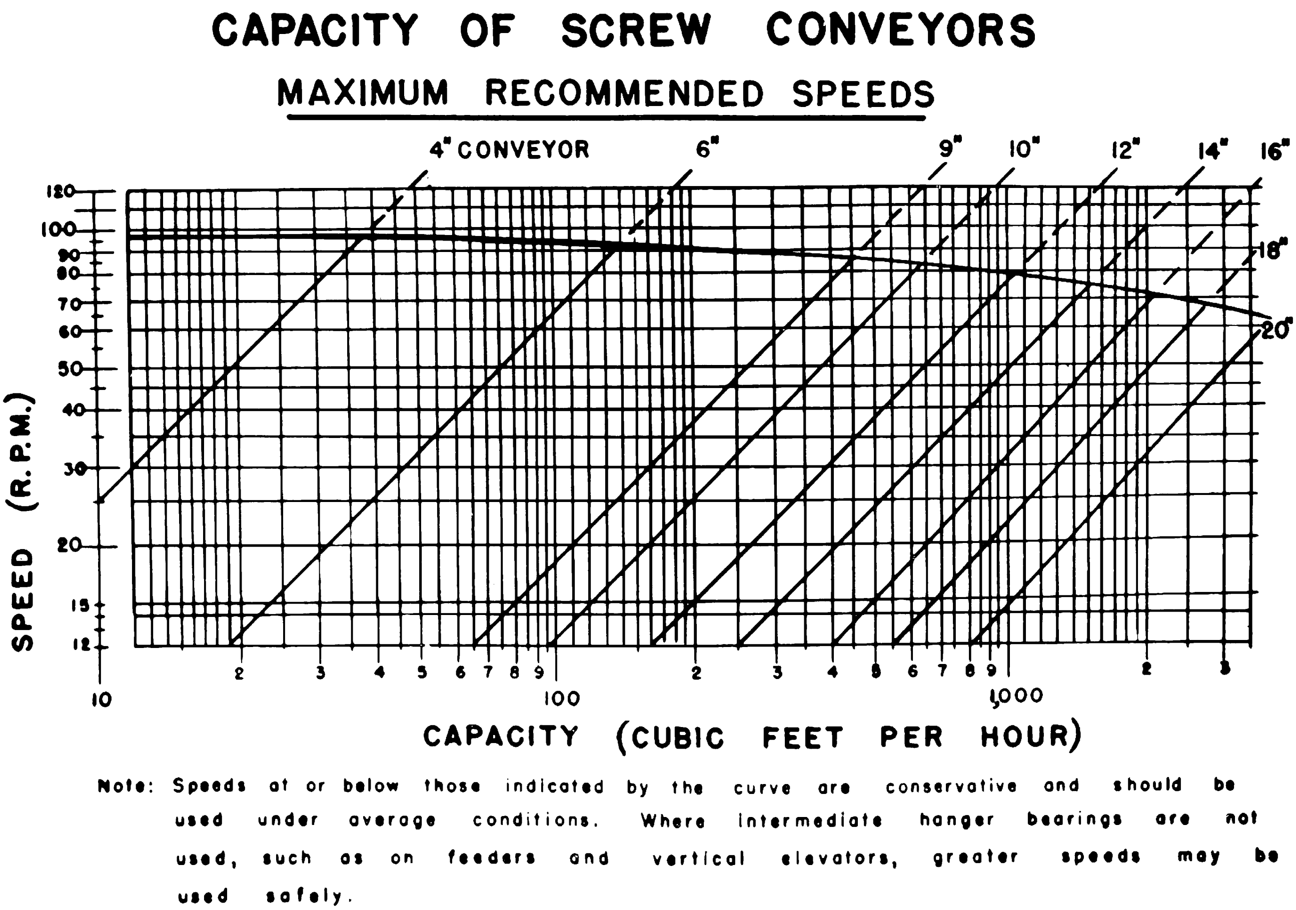


Figure 78.—Capacity of screw conveyors.

In some areas of the Cotton Belt, chain or scraper conveyors are used to elevate cottonseed from the seed pile into a truck for transfer to the mill. These scraper conveyors are similar to grain elevator conveyors; however, flights are normally shallow and have widths ranging from 12 to 18 inches. The capacity of such conveyors will depend on the incline needed. A rule of thumb chain belt capacity is: Horizontal, 115 percent of conveyor flight volume; 20° incline, 77 percent of flight volume; 30° incline, 55 percent of flight volume; and 40° incline, 33 percent of flight volume.

Theoretical horsepower requirements for flight conveyors can be determined by the following equation:

$$\text{Horsepower} = \frac{2_v L_c W_c F_c + Q(LF_m + H)}{33{,}000}$$

where v = speed of conveyor (f.p.m.)
L_c = horizontal projected length of conveyor (ft.)
W_c = weight of chain and flights (lbs. per ft.)
F_c = coefficient of friction for chains and flights
Q = pounds of material to be handled per minute
L = horizontal projected length of loaded conveyor (ft.)
F_m = coefficient of friction for material
H = height of lift (ft.)

The coefficients of friction range from approximately 0.25 for metal to metal contact to 0.50 for metal to wood contact. Materials coefficient of friction for cottonseed to metal is estimated to be approximately 0.80.

Normally, a 16-inch, 5-horsepower unit is capable of loading 30 to 40 tons of cottonseed an hour into an average height truck and trailer. Some provisions should be made for raising and lowering the incline section to adjust to the height of the sideboards.

Materials handling is a highly specialized enterprise. Its procedures and details have developed largely from usage and experience in cotton gins. Large installations should be designed and installed by a materials handling engineer. Smaller, less involved installations can be designed and installed by local mechanics or by plant supervisors and engineers.

COTTONSEED HANDLING AND STORAGE AT GINS

By C. S. Shaw and G. N. Franks, *cotton technologist and agricultural engineer, respectively, Agricultural Engineering Research Division, Agricultural Research Service*

Seed at gins may be handled readily by gravity, belts, screw conveyors, or pneumatic piping. There are several methods for handling seed to keep it pure. The belt and blowpipe types of conveying systems are self-cleaning, but screw conveyors must be hand cleaned between the ginning of different varieties. For other than single-variety gins, the use of belt or blowpipe conveyors is therefore desirable if an appreciable quantity of seed is to be saved for planting.

Where vertical lifts are employed, screw elevators are generally more satisfactory than are wooden-bucket elevators, which often have trouble with slipping belts and faulty alinement. In some instances seed may be conveyed by belts or low-pressure piping. Conveying seed by air in small pipes is now the general practice *(3)*.

Small-pipe systems are economical in operation and are relatively free from trouble. They enable the cotton producer and ginner to preserve the purity of the cottonseed because the apparatus is self-cleaning. They have adequate capacity for removing 70 to 160 pounds of cottonseed per minute, as fast as the cotton is ginned. Being light in weight, they may be stationary or portable and are a significant labor-saving device for quickly unloading trucks into railroad cars and for emptying the cars at seed-breeders' treating and delinting plants. They may also be used for carrying seed to storage bins and for moving it later for grading, sterilizing, and other processes at rates to suit the plant capacity. Cottonseed has been successfully handled by these small-pipe blowing systems for distances up to 700 feet at approximately half the operating power costs of larger pipe and fan methods.

A stationary small-pipe system is shown in figure 79. A self-cleaning seed belt is used to feed the system dropper that introduces the seed into the air pipe. A tight valve enables the operator to divert the seed to truck bin or to storage, and flanged piping and elbows provide the piping runs to points of delivery.

Air-Conveying Principles and Calculations

Pipes of 4- and 5-inch diameter have proved large enough for handling cottonseed in the average gins and delinting plants. The 4-inch pipe is sufficient for handling up to 3 tons of seed per hour. The 5-inch pipe is recommended for handling up to 6 tons of seed per hour.

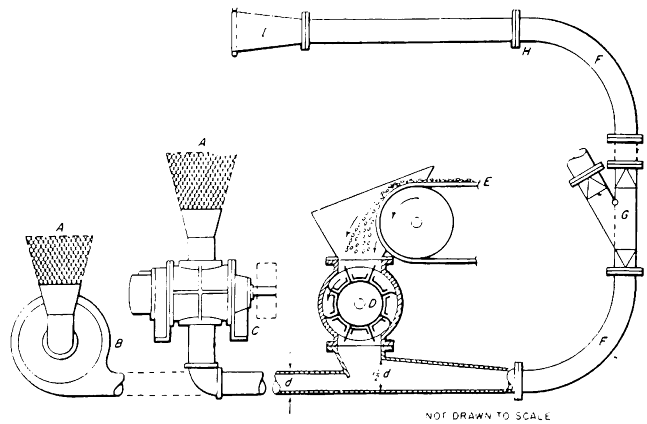


Figure 79.—Small-pipe piping system for cottonseed. ***A*****, 16-mesh air filter, or screen box;** ***B*****, turboblower;** ***C*****, rotary positive blower;** ***D*****, dropper, or vacuum-wheel feeder with 8 or more shallow pockets;** ***E*****, gin stand seed belt;** ***F*****, long-sweep, 36-inch radius elbows;** ***G*****, valve for diverting seed to bin or storage;** ***H*****, 6-bolt flange and rubber gasket;** ***I*****, funnel discharge for efficient delivery. Diameter at** ***d*****, 4 inches for 3 tons per hour stands; 5 inches for up to 6 tons per hour.**

For preliminary calculations to determine the total resistance pressures that the pump or blower must overcome, it is customary to allow 16 ounces' resistance (or 1 pound per square inch) for each 200 linear feet of piping. In calculating, each short elbow and each valve must be considered equivalent to approximately 15 feet of straight pipe. For a more accurate estimate on which the factory can provide the blower unit and suggest its speed, add up the pressure losses for the individual elements that make up the system, as follows:

	Pressure allowance per sq. in. (ounces)
4-inch piping, each 100 feet	6
5-inch piping, each 100 feet	5
For both 4- and 5-inch pipes:	
Elbow and valve, each	.8
Base and tapered discharges from dropper	2
Cyclone collector and sacker at end of pipe	1

This estimate is based on a velocity of 4,500 feet per minute, with volumes of 405 and 650 cubic feet per minute for 4- and 5-inch pipes, respectively.

Satisfactory mean or average air velocities within small seed pipes range from 4,200 to 5,200 feet per minute. Air volumes of about 4 cubic feet per pound of cottonseed have been used in short piping systems with an air pump, but it is advisable to allow 5 cubic feet where piping exceeds 250 feet, or where turboblowers are used. Since the velocity and volume of a conveying air stream depend on the average size and specific weight of the material, the above rules apply only to cottonseed.

For horizontal blowing of cottonseed, the lower limit of air velocity in the pipe should be not less than 4,000 feet per minute. No seed should pass through the blowers, regardless of the kind of system. Pipe joints should be tight and the valves and feeders well sealed for small-pipe systems.

Blowers and Air Pumps

Since operating air pressures for small-pipe systems usually range from 1 to 3 pounds per square inch, it is necessary to use either slow-speed positive-pressure rotary air pumps or high-speed centrifugal turboblowers. The two-lobe rotary air pump (fig. 80) is the type most commonly used

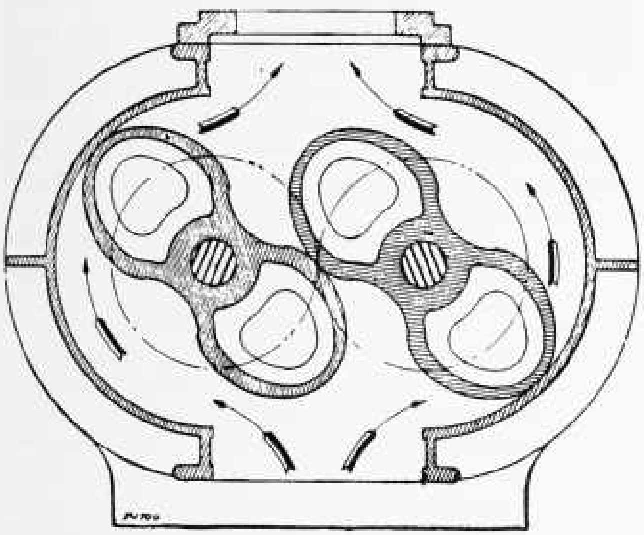


***Figure 80.*—Cross section of a typical positive-pressure 2-lobe rotary air pump used for conveying cottonseed. Rotation may be reversed if desired.**

and is known to the trade as a positive-pressure blower. Although the standard practice with liquids has been to place the suction intake on the underside and the discharge on the top side of the rotary pump, there are many advantages in reversing the method of seed handling. With the discharge underneath, dust and moisture are continually expelled from the blower, thus lessening wear and damage.

Single-stage, centrifugal turboblowers (fig. 81) that may be either belted or direct-connected and run at 3,500 revolutions per minute are used by various industries where the air pressures do not exceed 3 pounds per square inch. With motor, they weigh 350 to 500 pounds, compared with 400 to 550 pounds for the bare rotary pump.

For stationary installations where unskilled labor may tend to feed cottonseed in lumps or where handling is irregular and intermittent, positive-pressure blowers are recommended. These blowers can purge the piping to overcome minor chokages by a temporary increase in air pressure. The air pump also is more satisfactory than the turboblower where pipe runs are more than 200 feet long.

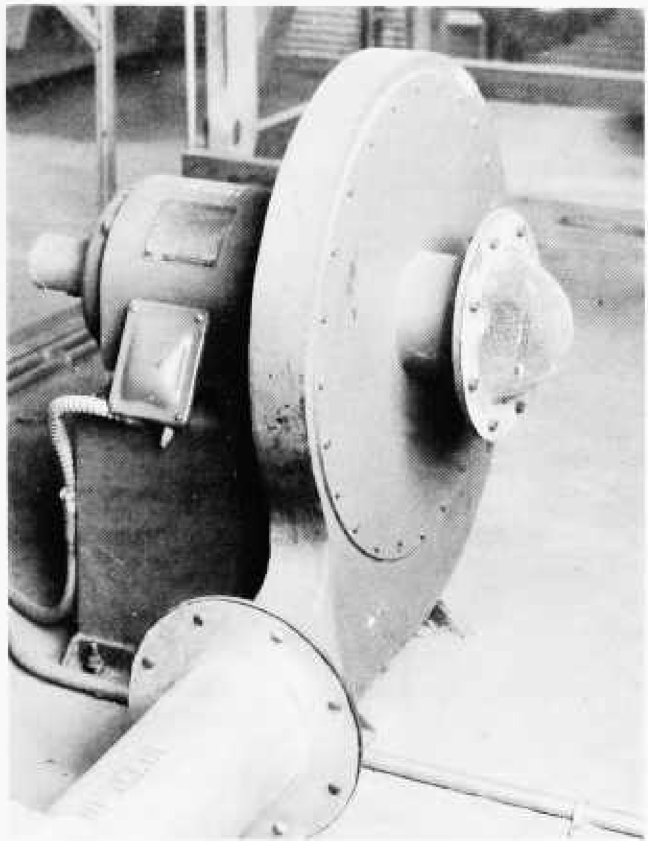


***Figure 81.*—Single-stage motor-driven centrifugal turboblower suitable for handling cottonseed.**

However, for portable and short-run installations, the centrifugal turboblower unit can be used advantageously. By means of temporary flexible connections, it can be made to serve in numerous ways.

Several portable units for loading and unloading cottonseed are on the market. They are similar in design to the one developed at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss. (fig. 82).

Performance data are given in table 13 for the rotary positive-pressure blowers now being used successfully at cotton gins and seed establishments.

Devices on inlets and outlets of blowers.—A screened intake, or air filter, is imperative on cottonseed-handling blowers to protect the lobes and casing from excessive wear and to prevent wisps of fiber and foreign matter from damaging and unbalancing high-speed blades. Screened-intake types of filters may be either factory built or homemade. Large areas of close-mesh bronze screen wire are necessary for homemade intake

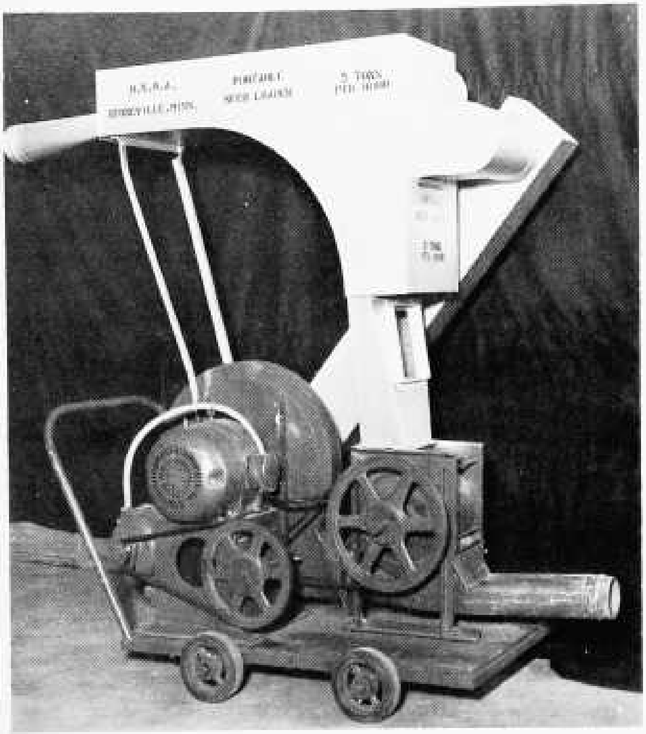


***Figure 82.*—Portable cottonseed unloader.**

filters. These filters should have at least 5 square feet of gross screen area, all accessible for daily or more frequent cleanings.

Relief valves are seldom used on positive-pressure blowers, because they prevent purging the system at higher pressures when chokages threaten. If used, they should be set to pop off (release) at double the working pressures.

Centrifugal turboblowers are obtainable with a blast gate or butterfly type of control valve on the blower outlet, so that adjustment can be made to prevent overloading the motor. Since the outlet diameter of cottonseed turboblowers is usually 6 inches, the control valve becomes a necessary adjunct to the regulation of the 4- and 5-inch seed lines used at cotton gins; and it also is a desirable device for portable short-run installations.

Fitting a cheap, small-diameter air-pressure gage on the outlet of all seed-handling blowers is recommended, so that the operators may be aware of excessive pressures and regulate their units more efficiently.

Feeding Seed Into Pressure Pipes

Cottonseed may be satisfactorily fed into a small- pipe pressure system by means of a dropper, or rotary sealed wheel (sometimes called a vacuum wheel), that mechanically drops the seed into the air line on the discharge side of the pump or blower. "Seed plugs" of auger type have also been used successfully. Handling cottonseed by suction requires a special separator. But the expense of a separator is not warranted unless the rate approaches 40 tons or more per hour, in which case motors up to 75 horsepower and extremely large blowers are needed.

Speeds of the rotary sealed wheel, or dropper, should be relatively low—30 to 60 revolutions per minute—and internal seals at the ends and pocket divisions are necessary to prevent serious air leakage. A machined dropper should handle up to 4½ tons of cottonseed per hour at normal speed with 5-inch piping connections. It is customary to provide an independent drive for the hopper, because its speed is much slower than that of either a rotary positive-pressure blower or a centrifugal turboblower. A taper of 20 inches or more should be used on feeder base outlets or jet boxes to prevent chokage. Jet boxes must be set as close to the feeder as possible.

TABLE 13.—*Performance data for rotary positive-pressure cottonseed blowers*

(Adapted from published tables of manufacturers)

Seed capacity	Size[1]	Pipe diameter	Speed	Pressure					
				1 pound[2]		2 pounds[2]		3 pounds[2]	
				Volume	Power	Volume	Power	Volume	Power
	No.	*Inches*	*R.p.m.*	*Cu. ft.*	*Hp.*	*Cu. ft.*	*Hp.*	*Cu. ft.*	*Hp.*
			575	325	2.0	300	3.8	280	5.7
Up to 90 pounds per minute	615	4	615	350	2.1	325	4.1	310	6.1
			690	400	2.3	375	4.6	360	7.0
			490	480	2.8	450	5.6	425	8.5
Up to 160 pounds per minute	717	5	575	570	3.2	540	6.5	515	9.7
			690	700	4.0	670	8.0	650	12.0
			717	730	4.1	690	8.2	670	12.3

[1] One of several trade designations.

[2] 4 cubic feet of air per pound of seed may be allowed at 1-pound pressure. At all higher pressures, allow 5 cubic feet.

Piping

Standard 20-gage galvanized pipe or galvanized light-weight tubing is recommended where the piping is to be exposed to the weather. Joints should be flanged wherever seed passes through the pipe. Six-bolt companion flanges with rubber gaskets are recommended. On the blower intake and discharge, or at points ahead of the seed dropper, standard screwed pipe and fittings can be used for handling the compressed air.

Seed-handling elbows should be 18 gage or heavier and must be of the long sweep type to give satisfactory service without chokage. Elbows of 36-inch radius are recommended for pipes 4, 5, and 6 inches in diameter.

Risers, or lifts, in seed piping should preferably be on an incline rather than vertical, to use minimum angles at elbows and to save the piping length that diagonals afford in comparison with right-angle runs.

Valves, Branches, and Discharges

Valves for small-pipe systems frequently give trouble in operating, especially where they are of inferior workmanship and are poorly fitted for tightness. Not more than two valves should be used in the ordinary cottonseed system, because leakages and careless adjustments invite trouble.

In the design of vane-type seed valves, the take-off angle should not exceed 30°. The deflector vane should be of adequate thickness and should be well fitted into the body of the valve, with the seated end so adjusted that seed chokage will not be caused by lint or seed building up at the valve intake.

The discharge funnel (fig. 79, *I*) materially assists airflow through the pipe to open bins, but it should not be aimed at a blank wall or at any object that might cause the seed to crack.

Cyclone collectors of seed for delivery to sackers may be used at the ends of small-pipe systems. The downspouts from these collectors should be 8 inches or more in diameter to prevent choking or bridging of seed at the base of the collectors.

Other Features of Small-Pipe Systems

Distances for conveying cottonseed with low- and medium-pressure systems—1 to 6 pounds' pressure per square inch—are limited between approximately 200 and 700 feet of piping length. Since no two systems are alike in length and in number of risers and elbows, the limitations of pressure and volume incident to the type of blower must be carefully considered in the design of any small-pipe system.

Power cost is usually about half that of ordinary cotton-gin fan systems. Initial cost of small-pipe systems using positive-pressure blowers is somewhat lower than that of the gin fan system.

The efficiency of the small-pipe handling system depends on correct installation. Because it is portable, it is ideal for year-round use in unloading and loading operations between trucks, railroad cars, and storage houses.

Weighing or Measuring Equipment

Most modern gins are equipped with seed scales for weighing cottonseed from each bale before it is discharged into conveying vehicles or before it is carried into storage (figs. 83 and 84).

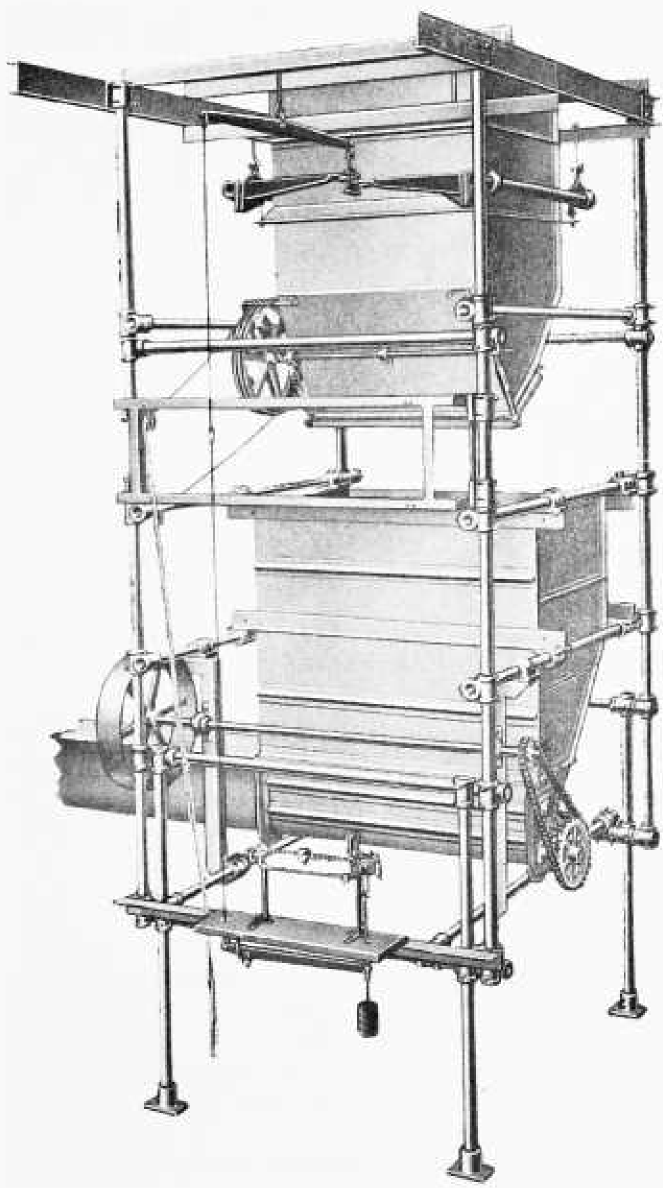


Figure 83.—Cottonseed scales for use in cotton gins.

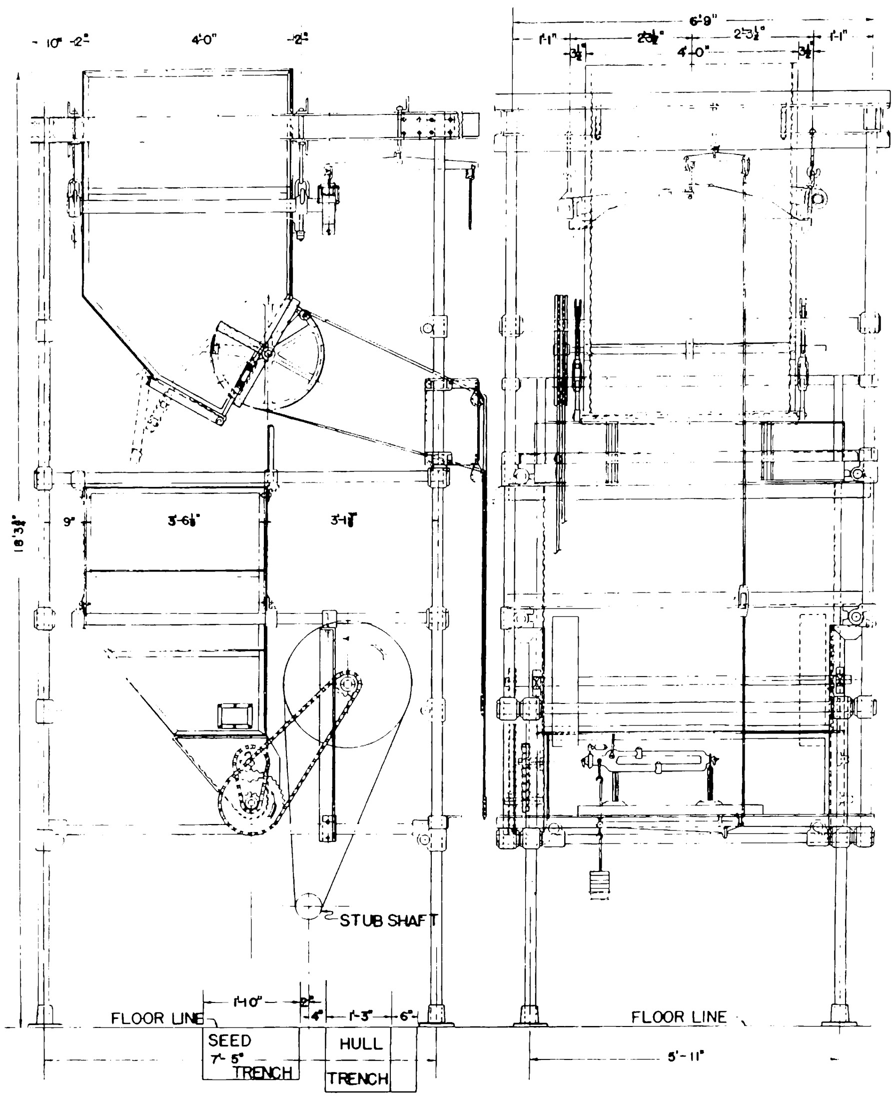


***Figure 84.*—Line drawing giving dimensions of cottonseed scales.**

A comparatively new type of cottonseed weighing or measuring device has been placed on the market in recent years. It consists of a small water-wheel-type device that receives the seed from the gins and dumps automatically when each succeeding pocket of the wheel has received a given amount of seed (figs. 85–87). Depending on the size of the unit, each 10 or 20 pounds of seed is measured as it is dumped, and the device can be equipped to signal the completion of each bale.

From these weighing or measuring devices the seed is conveyed by air, auger, or lift to trailer bin, seed storage, or railroad car; or for special processing such as sterilizing, delinting, and treating.

Handling Cotton Planting-Seed

Cotton planting-seed (*5*) usually is delinted and treated in the storage period between the time of ginning and the next planting season.

About 300,000 tons of cotton planting-seed are required annually in the United States, in addition to emergency replanting demands. Both large and small producing communities frequently need information on the best handling methods.

Different methods of handling cotton planting-seed, including storage, bulk cooling, grading, cleaning, delinting, and treating, are being used at cotton gins where purity and preservation of the seed are important adjuncts to sales. The methods are applicable on the farm as well as at the gin. All are safeguards against hazards of foreign matter, excessive moisture, plant diseases, and other causes of quality loss. Each method may assume special importance to cotton producers in meeting regional variables encountered in preserving and improving quality.

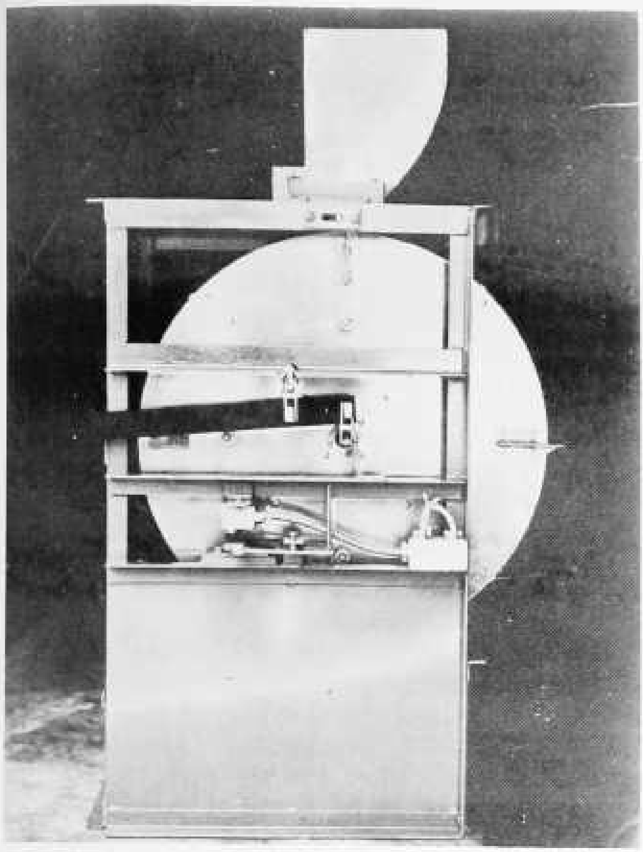


Figure 85.—**Outside view of water-wheel-type cottonseed measuring device.**

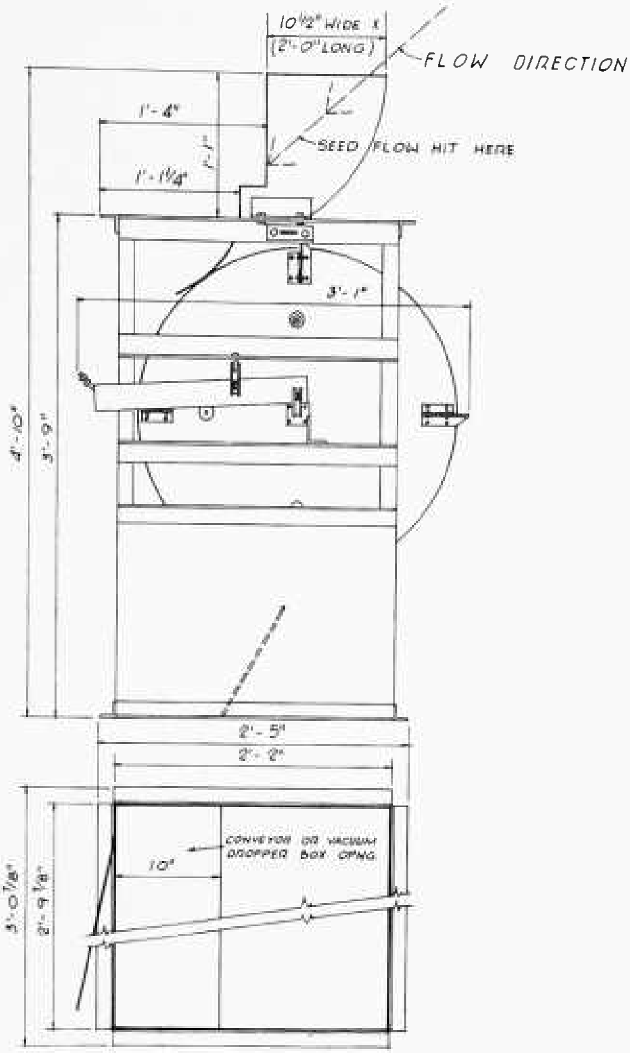


Figure 86.—**Line drawing of water-wheel-type cottonseed measuring device.**

Storage

The necessary shelter for cotton planting-seed is usually provided in regular storage houses. Table 14 gives the capacity of storage houses of various dimensions. Without being heavily packed, cottonseed usually requires about 80 cubic feet of space per ton; and 1 cubic foot of cotton-

Table 14.—*Capacity of cottonseed storage houses of various dimensions* [1]

Inside width (feet) [2]	Capacity per linear foot	Capacity, when length of house is— 20 feet		40 feet		60 feet		80 feet		100 feet	
	Tons	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*	*Tons*	*Bushels*
18	1. 8	36	2, 300	72	4, 600	108	6, 900	144	9, 350	180	11, 500
20	2. 0	40	2, 600	80	5, 200	120	7, 800	160	10, 400	200	13, 000
22	2. 2	44	2, 850	88	5, 700	132	8, 550	176	11, 400	220	14, 250
24	2. 4	48	3, 100	96	6, 250	144	9, 350	192	12, 500	240	15, 500
26	2. 6	52	3, 400	104	6, 750	156	10, 150	208	13, 500	260	16, 900
28	2. 8	56	3, 650	112	7, 300	168	10, 900	224	14, 550	280	18, 200
30	3. 0	60	3, 900	120	7, 800	180	11, 700	240	15, 600	300	19, 500
32	3. 2	64	4, 150	128	8, 300	192	12, 450	256	16, 600	320	20, 800
36	3. 6	72	4, 600	144	9, 200	216	13, 800	288	18, 400	360	23, 000

[1] Based on loosely packed seed (estimated volume, 80 cubic feet per ton). Tightly packed seed has an estimated volume of 71 cubic feet per ton.

[2] Plate height, 19 feet; average depth of seed pile, 8 feet.

seed thus weighs about 28 pounds. Experienced seed breeders do not advise storing planting-seed to a depth exceeding 8 feet.

Producers of pedigreed and certified planting-seed have found that seed with a moisture content greater than 12 percent should not be placed in bulk storage. They suggest that a 60-day rest period in storage is desirable for freshly ginned seed before samples are taken for germination tests.

The fact that seed may have undergone a 10-day storage period without undue heating or damage is no guarantee that it will continue to keep. The free fatty acid content can increase by almost imperceptible temperature rises. Fluctuations may occur in seed temperatures within ranges of 10° or 12° as the weather changes, and yet the general trend of moisture content may be downward if the initial moisture content of the seed was below 12 percent when it was put into storage. For practical purposes, 12-percent moisture content is the critical point for seed in storage. Every effort should be made to bring the moisture content of all stored seed down to between 10 and 11 percent as soon as possible. A bulk storage system is shown in figure 88. This type of system is in widespread use.

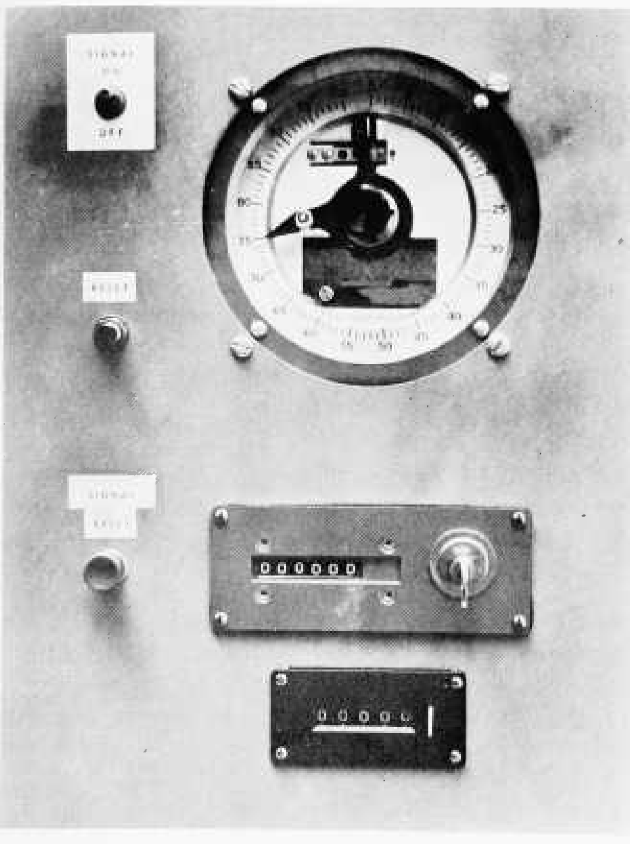


Figure 87.—**Cottonseed recording and signaling device.**

Cooling and Airing

The type of construction used in the storage house will dictate the choice of cooling system. Enclosed sheds with wooden floors are common; some are provided with crawl underspace, and some have a hall between two rows of bins. Another type of storage house is elevated on sturdy posts above a driveway, so that trucks may drive under the storage space and receive seed through trapdoors. A third type for storing seed in either bulk piles or bins consists of a metal-sheathed shed erected on a concrete slab. The slab may be on the ground, or it may be on footing walls and earth fill. In the latter, underfloor laterals from a centrally located suction tunnel, either above or below floor level, may use suction holes through the floor for cooling and airing the seed.

Several good systems are shown in figures 88 to 91. Each is satisfactory; loss of seed is extremely low in such installations.

During the period between planting and harvesting, the storage house may be used for other purposes if it has a removable grid floor or laterals (as shown in figs. 88 to 91). Other seeds and grains can be handled readily with the cooling system, but methods of filling the storage space may differ.

For bulk cooling of cottonseed, allow 3,300 cubic feet of air per minute per ton of seed for each 1 percent of drying desired per hour. The air must be drawn through the seed during daylight hours in fair weather only (unless ample volumes of hot air are blown into the seed house above the seed pile), and then preferably between 10 a.m. and 4 p.m. For large volumes of seed, the time may be lengthened proportionately, so that the volume of air allowed per ton of seed per hour is reduced in order to spread the drying to more seed. Thus, if 1,100 cubic feet of air per minute is allowed per ton of seed, 3 hours of drying will usually reduce the moisture content about 1 percent.

In planning for air delivery or suction systems for cooling cottonseed in bins and drying it without heat, the element of time and the initial moisture content of the seed are important.

As a rule of thumb, a No. 35 cotton-gin fan with 18 blades will deliver 3,500 cubic feet of air per minute against a resistance of 5 inches (as shown on a U-tube water-pressure gage) at a speed of approximately 1,300 revolutions per minute (table 15). A No. 35 fan with 6 or 8 straight blades and a fan wheel 32 inches in diameter will deliver 3,500 cubic feet of air at a speed of about 1,000 revolutions per minute.

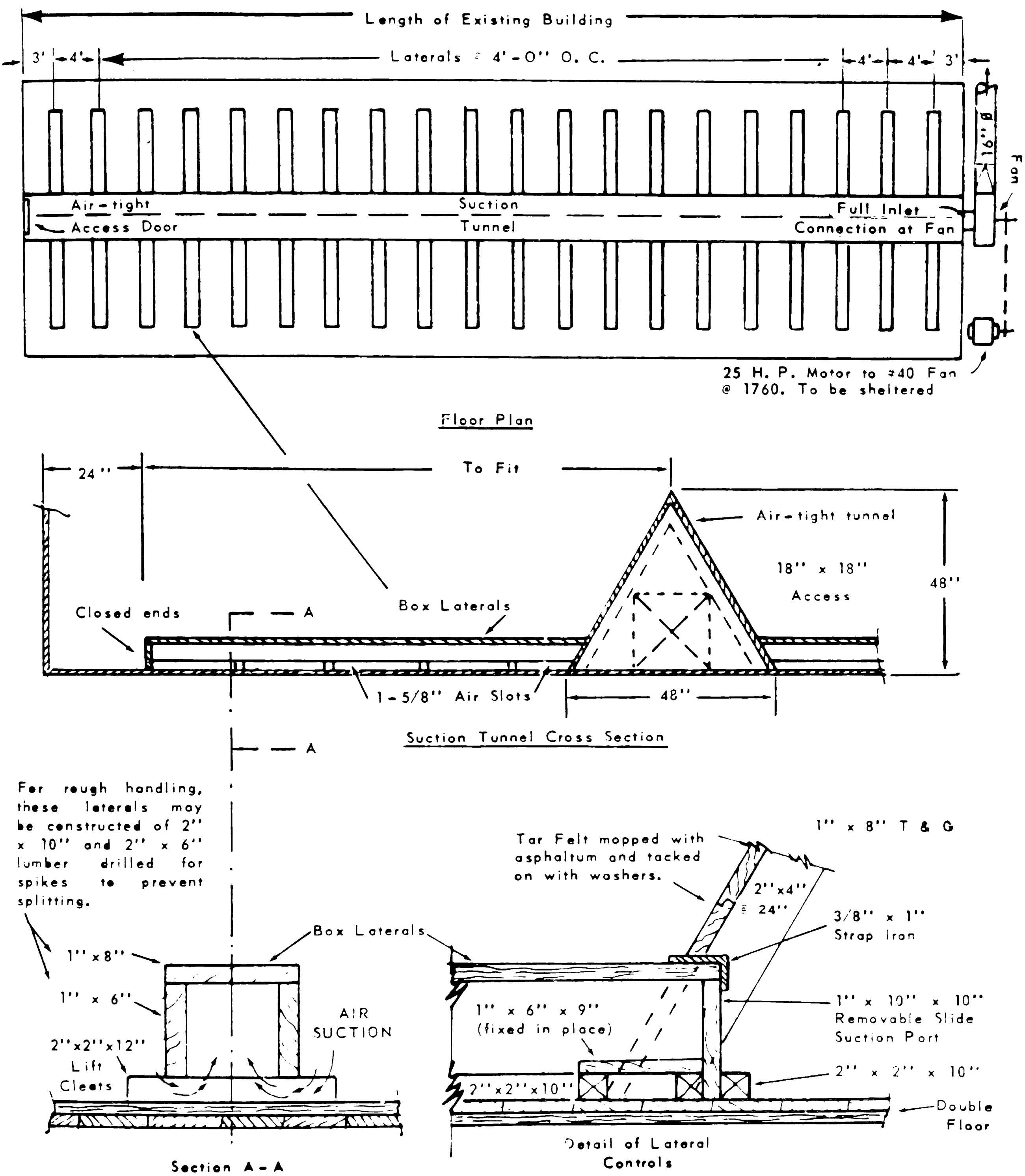


Figure 88.—Diagram of central triangular tunnel and laterals for seed storage. If side access doors are provided at intervals, a seed belt or auger may be used within the tunnel to empty any part of the seed house.

TABLE 15.—*Comparative data on cotton-gin fans of different sizes for drying seed in piles or bins* [1]

Type of fan	Fan wheel		Revolutions per minute	Volume [2]
	Blades	Diameter of wheel		
	Number	*Inches*	*Number*	*Cubic feet*
Type C: [3]				
No. 35	18	23.5	1,333	3,500
No. 40	18	27	1,126	4,000
No. 45	18	30	1,000	5,100
No. 50	18	33	906	6,252
Plain: [4]				
No. 35	6 or 8	32	1,000	3,500
No. 40	6 or 8	32	1,000	4,000
No. 45	6 or 8	32	1,000	5,000
No. 50	6 or 8	32	1,000	8,000

[1] Based on a seed-pile depth of 8 feet.
[2] Air delivered per minute against an estimated resistance of 5 inches as measured on a U-tube water gage.
[3] Courtesy of Clarage Fan Co.
[4] Courtesy of Boardman Co.

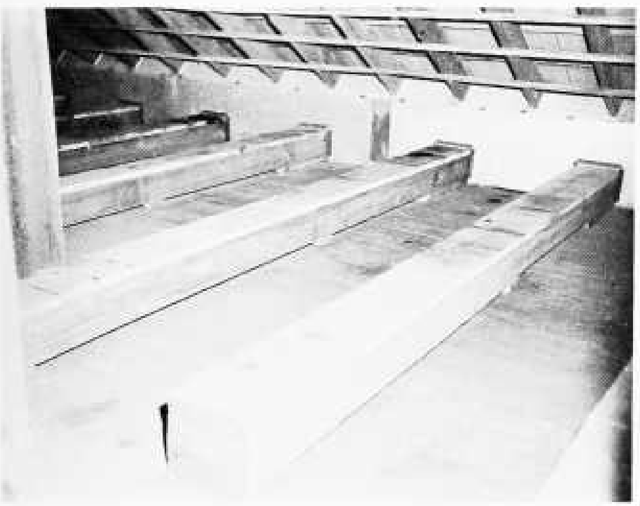


Figure 89.—**Removable box laterals, 4 feet apart on centers, plugged into a side tunnel or suction trunk.**

At a given speed, the volume (cubic feet of air delivered per minute) of a centrifugal fan increases as the resistance it has to overcome decreases, and there is a corresponding increase in horsepower consumption. Therefore, the type of cooling fan and the size of motor are of major importance in the satisfactory and economical operation of a cooling system. Backward pitch blades to fan wheels with load-limiting characteristics are advisable.

Suction resistance in pulling air through cottonseed is given in table 16.

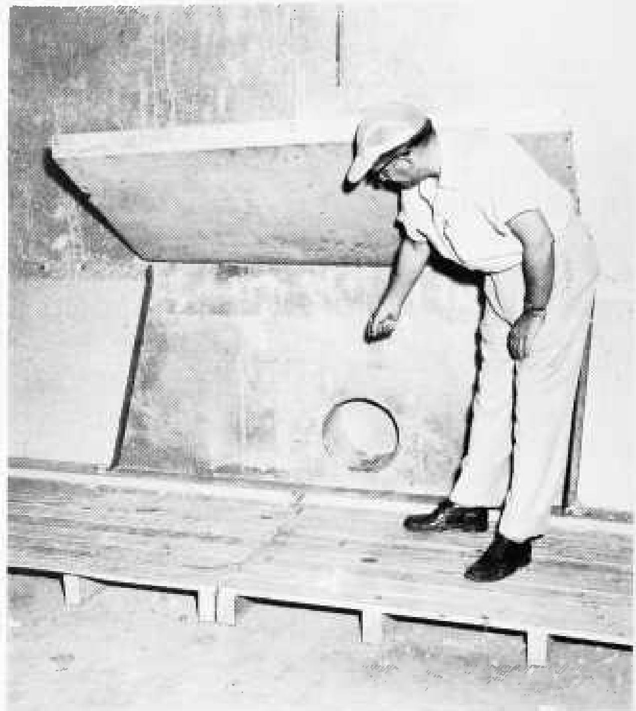


Figure 90.—**Removable grid or lattice floor, with side tunnel or suction trunk. This system can be used for either bulk or sacked seed.**

TABLE 16.—*Suction resistance in pulling air through cottonseed, with a starting air volume of 4,000 c.f.m.* [1]

Depth of cottonseed	Resistance of cottonseed with a moisture content of—		Depth of cottonseed	Resistance of cottonseed with a moisture content of—	
	13 percent [2]	10 percent [3]		13 percent [2]	10 percent [3]
Feet	*Inches*	*Inches*	*Feet*	*Inches*	*Inches*
0	0.0	0.0	8	0.7	0.6
1	.3	.3	9	1.0	.7
3	.4	.4	10	1.0	.7
4	.4	.5	11	1.2	.8
5	.6	.5	12	1.7	.9
6	.7	.5	13	2.5	1.0
7	.7	.6			

[1] Cottonseed had been in storage 6 months.
[2] Average resistance per foot = 0.19 inch of water.
[3] Average resistanee per foot = 0.08 inch of water.

Delinting and Treating

All "gin-run" seed should be cleaned, to remove lightweight seed and trash, before it is delinted and treated. For low cost and best operation, grading, culling, and cleaning should be followed by delinting and treating in a continuous operation. To prevent rehandling, there should be a reasonable working balance in the relative capacities of graders, linters, and treaters.

Figure 91.—**Seed stored for drying in a removable grid or lattice floor arrangement.**

Mechanical delinting machines.—The fuzz and other short fibers (linters) that adhere to the cottonseed after ginning are usually removed from the seed at the oil mill to make it easier to extract the oil. The machines (also called linters) that are used to delint the cottonseed have gradually been increased in size from 106 saws per linter to 141, and then to 176. Thus, new and used equipment for delinting cotton planting-seed is available in three sizes.

Mechanical delinting machines with 141 saws range in capacity from one-half to three-fourth pound of cotton linters per saw per hour, or approximately three-fourth bushel of planting-seed per hour per each 10 saws.

Successful community delinting and treating plants are operating in each region of the Cotton Belt. Some of these plants are using discarded linting machinery from local cotton oil mills.

Overhead distributors to linter feeders and linters may be either, belt-type or auger-type conveyors. The latter combine self-cleaning lifts with horizontal runs.

Power requirements for each linter and feeder range from 10 to 15 horsepower; for the overhead distributing system, from 5 to 7½ horsepower; for fans, an estimated 4 horsepower; and for seed-treating machines equipped with fans, from ¾ to 3 horsepower. Information on power requirements of delinting and treating equipment may be obtained from the manufacturer.

708-555 O-64-6

Effects of Drying Seed Cotton at the Gin on Cottonseed in Storage

The conditions under which cottonseed is stored have an important bearing on the quality of the seed after prolonged periods of storage (*14*). Excessive moisture content and overheating of the seed not only have an ultimate adverse effect on the quality of oil extracted from stored seed but also may influence germination.

Seed cotton drying does not adversely affect the storage qualities of cottonseed. Results of a 2-year study on 23 cottons showed that with green-damp or wet seed cottons, the process of artificially drying before ginning did not increase the rate of deterioration of the seed in storage; in fact, it retarded the formation of free fatty acids. The higher the drying temperature, the lower the free fatty acid content of the seed at the end of the 90-day storage period.

The seed from cottons picked and ginned in a dry condition did not show a significant change in free fatty acids during the 90 days of storage, and the added removal of moisture by artificial drying therefore did not affect this property in the dry seed.

Artificial drying of seed cotton having a 12-percent or higher moisture content caused temperature increases in the ginned seed that ranged from 6° F. with a drying air temperature of 160°, to 11° with a drying air temperature of 220°. With seed cotton having less than 12-percent moisture content, temperature increases ranged from 8° to 15°. In a few days, however, natural cooling eliminated most of the temperature differences, and thereafter the seed ginned from undried, damp cotton was only slightly higher in temperature than that from dried, damp cotton. Seed from undried and dried cotton of low-moisture content had practically the same temperatures in storage.

Drying wet cotton at the time of ginning with an air temperature of 220° F. removed a maximum of 0.7 percent of moisture in the seed. At the end of 90 days' storage, the difference in moisture content between undried and dried lots was somewhat reduced; the undried seed lost 1.2 percent of moisture, and the seed dried at high temperature lost 0.9 percent. Little difference in moisture content of the seed ginned from the dry cotton was noted at the end of the storage period. The dried seed gained moisture, the undried seed lost moisture, and all ultimately reached the same level of moisture content.

Germination tests on the undried and the dried seed indicated that drying, whether at the time of ginning or after 90 days' storage, improved the percentage of germination.

Cottonseed that developed high free fatty acid content had a tendency toward low germination.

The data indicate that a free fatty acid content of 2 percent becomes critical so far as cottonseed germination is concerned.

The effect of conveying the seed from the gin stands to storage by means of unheated and heated air was slight. Temperature of seed conveyed by unheated air decreased slightly. Temperature of seed conveyed by air heated to 120° F. increased only a few degrees. Temperature of seed conveyed by air heated to 180° rose an average of 6° for seed 12 percent or higher in moisture content. These increases were only temporary, and temperature returned to normal in 3 or 4 days.

In most instances, the use of air in conveying the seed slightly reduced the moisture content of wet seed, but the reductions were generally too small to be significant. The moisture and temperature effects were also insignificant with dry seed; and the free fatty acid content and germination of both wet and dry seed after 90 days' storage were not materially affected by the different methods of conveying the seed.

USDA-Developed Cottonseed Drier for Use at Gins

Extensive programs of research embracing cottonseed drying, cleaning, and sack and bulk storage were carried out over a period of years at the U.S. Cotton Ginning Research Laboratory, Stoneville, Miss. The tests centered around the development of a large, gin-capacity drier, designed and fabricated at the Laboratory (*14*) and made up of inclined, revolving, perforated cleaning drums equipped for heated air application and subsequent cooling (figs. 92 and 93).

Description of drier.—The flow of seed from the cotton gin is directed into a feeder mounted above the drier, which provides for the delivery of the cottonseed into the drier.

The uppermost section of the drier consists of two drums, with the inner drum having large perforations and arranged so as to revolve inside the outer drum. The inner drum with its large perforations permits the cottonseed to pass into the outer drum but retains the large trash (consisting mainly of hulls and grabbots) and conveys this into the trash discharge. The outer drum slowly conveys the cottonseed, while drying, into the next drum immediately below but in the same drying chamber. The smaller perforations in the outer drum and the second large drying drum permit the smaller trash to pass into the trash conveyor for discharge. Again, the seed is slowly conveyed until it reaches the end of the drum and is discharged in a steady flow into the cooling drum, where unheated air is pulled in at the rate of 7,000 cubic feet per minute. The cooling drum also has small perforations that permit the sifting out of small trash while the seed is carried to the end of the cooling drum for final discharge into the seed line.

An average of 4 minutes is required for the seed to pass through the drying drums. The seed is then exposed for 2 minutes of cooling during passage through the cooling drum before it reaches the final discharge.

A 1 million B.t.u. gas-fired burner is used as the source of heat, in conjunction with a low-horsepower but high-volume, hot-air fan suitable for delivering approximately 5,000 cubic feet of air per minute. The hot-air intake to the drying

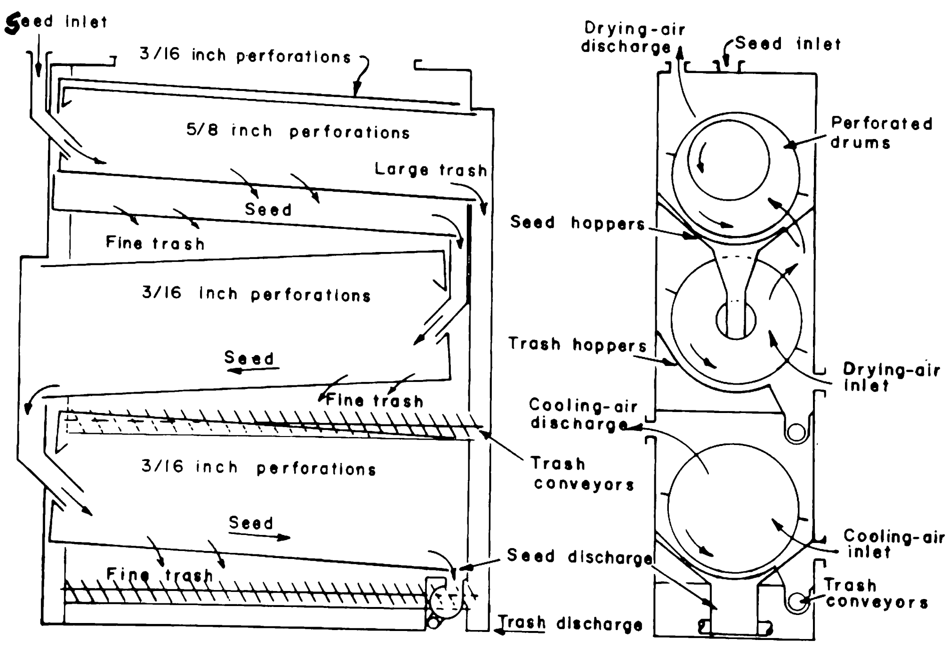


Figure 92.—Cross section of USDA-developed cottonseed drier.

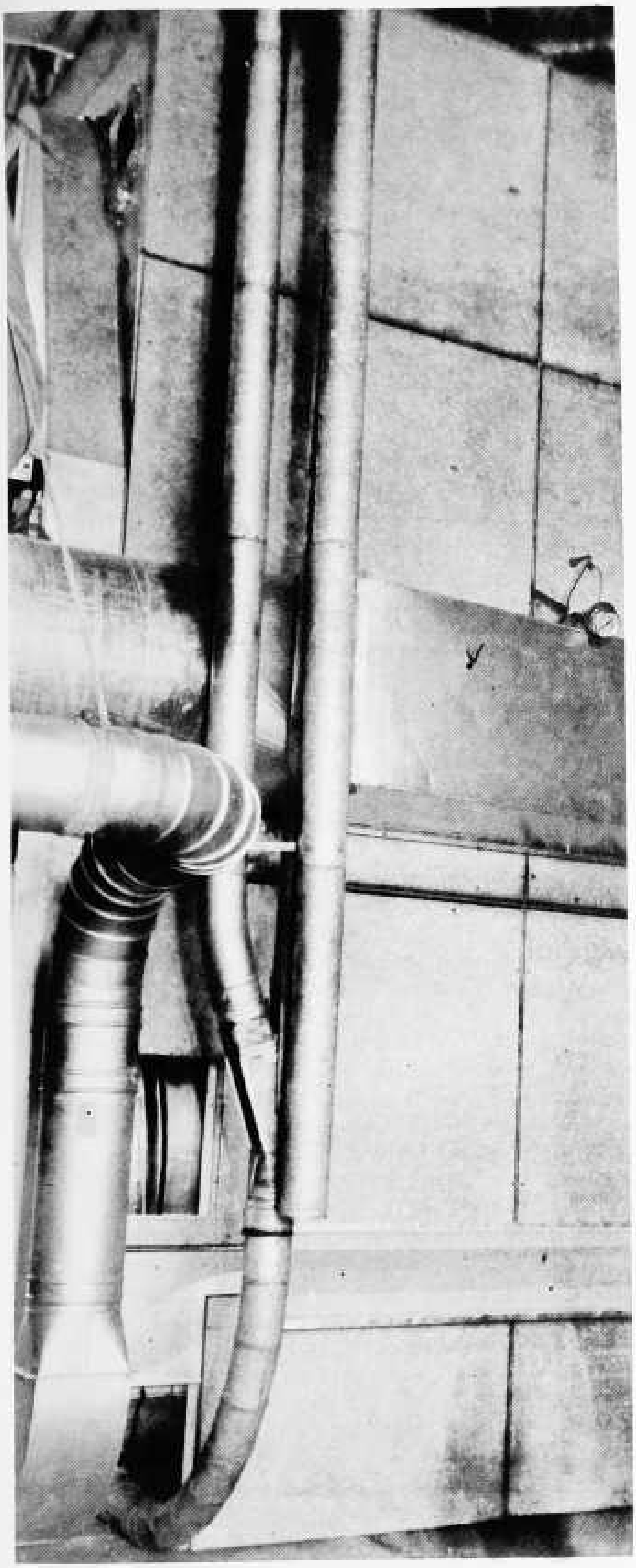


Figure 93.—**Side view of completed cottonseed drier showing hot-air intake to drying chamber, cold-air intake to cooling chamber, 5-inch seed discharge pipe, and 10-inch trash discharge pipe.**

chamber is provided with directional vanes to give good distribution of the hot air the full length of the drier. The cool-air intake should be provided with a ⅛-inch mesh screen for protective purposes.

Cottonseed drier research findings.—The results of the cottonseed drying and cleaning research show that—

(1) Cottonseed may be dried and cleaned at gins so as to significantly improve grades and corresponding marketing values.

(2) The operation may be conducted concurrently with the ginning process, and at commensurate rates of seed flow.

(3) Artificial drying offers important advantages in the preservation of cottonseed in storage.

(4) Artificially dried cottonseed should be adequately cooled before being left dormant in bulk storage.

(5) Drying at the cotton gin does not stop the development of free fatty acids that might have already started in cottonseed, but drying does retard their progress.

(6) Drying and cleaning cottonseed before storage provides significant improvement in the grade of cottonseed linters.

(7) Cottonseed drying at the cotton gin offers substantial benefits in preserving seed germination.

(8) Electric energy and fuel costs for drying cottonseed vary according to local rates, but should be substantially less than $1 per ton.

LINT FLUES AND CONDENSERS

By J. B. Cocke, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Lint Flue

The lint flue may be located either above or below the level of the operating floor in a cotton gin. Although the lint flue is usually above the floor, in some recent installations it has been placed below the floor to conserve space. A submerged lint flue should be placed above the pit floor to avoid damage caused by water seepage.

A properly proportioned lint flue is provided by the manufacturer for each gin installation. Addition of one or more gin stands not included in the initial installation may require a change in the lint flue. The manufacturer should be consulted as to lint flue requirements when additional gin stands are added.

Inspection.—The lint flue should be free of any obstructions that might cause tag buildups. Accumulation of lint on rivet heads, wire edges, and rust spots may result in chokage in the lint flue.

The obstructions may be removed with a file or with steel wool. Rust spots may be removed with steel wool.

Access doors to lint flues should fit snugly to prevent lint fly from being blown into the gin house.

Operating pressures.—The ginned lint is blown from the gin saws through the lint flue to the condenser by the air current created by the brushes of brush gins or by the air from the blast fan of air-blast gins. The maintenance of proper static pressures in lint flues is very important, because too much pressure will produce backlash and its attendant troubles, especially if the condenser is not large enough. Lint flue pressures should not exceed one-half inch of water for brush gins or three-fourth inch of water for airblast gins. Many of the gins in operation are feeding into lint flues that are connected either to lint cleaner condensers or to battery condensers having duct fans installed in the system. The pressure in the lint flue of high-capacity gins can be held to the operating maximum without any difficulty by selecting the correct size of duct fan for the installation.

Deflectors.—A deflector in the lint flue is one of the most effective means of preventing big-ended bales. The deflector is generally located in the lint flue just ahead of the transition section and helps prevent an uneven mass of lint from collecting on the condenser screen. Lint flue deflectors vary according to manufacturers' designs, but all serve the same purpose.

Condensers

Condensers employ either one or two slow-turning screened drums on which the ginned lint forms a batt. The batt is discharged between doffing rollers to the lint slide. The air is separated from the lint by venting the air through the screened drum to its ends where it is discharged in the direction provided in the manufacturers' designs. Air from the updraft-type condenser is discharged through vents in the roof of the building. Air from the downdraft-type condenser is usually discharged through vents in the side of the building directly into a dust house.

The free areas of the condenser screens and vents should exceed that of the lint flue system to prevent resistance or backlash, which causes chokage.

Adequate condensers properly installed should be little affected by prevailing winds, if they are properly shielded by dust caps or a dust shed.

Although a majority of gins use the blow-type condenser, modern cotton gins are making use of suction condensers for handling fiber from lint cleaners and roller gins. Suction condensers are readily adaptable to all kinds of gins. They have several advantages over blow-type condensers because they eliminate dust and backlash and give a more easily controlled, uniform batt. With dust flue fans, the size of the battery condenser needed to handle a given volume of air may be reduced materially, since the slight additional back pressure caused by the smaller screen surfaces and smaller dust flues may be overcome by the dust flue fan.

In some areas of the Cotton Belt, a condition known as "hairing-over" occurs. Under certain conditions, fibers that are floating individually in the air manage to tie themselves around the wires of the condenser screen. An accumulation of these hairs may restrict the flow of air through the condenser and thus create backlash. Some condensers are equipped with a spring-loaded wiper that is held against the screen surface to overcome the hairing-over condition.

Diameters of conventional condenser drums with working lengths of 54 inches range between 3 and 8 feet, according to the number of gin stands. The drum speed ranges from 6 to 12 revolutions per minute.

Adjustments and maintenance of condensers.—With condensers of the updraft type, the windboard should be set to allow a small amount of air to float the batt of lint. This will ordinarily be a crack of about 1.2 inches between the windboard and the rubber flaps on the bottom doffing roller.

The speed of the screen drum should be regulated so that enough of the screen is exposed to permit air to escape and to avoid backlash.

With condensers of the downdraft type, the speed of the screen should be regulated to prevent backlash and to provide a good sampling batt.

The two doffing rollers should be set to allow three-eighth-inch to seven-sixteenth-inch space between the two rollers. This space should be large enough so as not to cause a permanent "set" in the flights, which would partly destroy their efficiency. The doffing rollers should show the same clearance at both ends to assure their equal spacing. Rough areas on the rollers may be removed by smoothing with fine steel wool.

The flashing seal should not extend any farther down on the roller than is necessary. Extending the seal too far over the roller will cause the top roller to lose its grip. This, in turn, will affect its directing the batt down to the bottom roller that is equipped with flights.

Generally, the screen area, air volume, and design of the entry to the condenser are the critical components that primarily determine the performance of the condenser. The diameter of the condenser drum is usually determined by the volume of air that must pass through that drum and by the allowable pressure drop. The doffing roller speed, which is directly proportional to the condenser drum speed through a fixed chain drive, is determined by the volume of lint that the condenser must handle.

The condenser and dust flue should be inspected daily for lint accumulation. Accumulated lint should be removed to reduce possible damage by fire.

The drive chain should be inspected daily to determine if it is running true on the sprockets. The idler should be adjusted to allow a small amount of slack in the chain. Sufficient oil should be applied to the chain to prevent the chain from cutting the sprocket.

COLLECTING GIN WASTE

By V. P. MOORE and E. A. HARRELL, *cotton technologist and agricultural engineer, respectively, Agricultural Engineering Research Division, Agricultural Research Service*

The most widely used devices for collecting waste in gins are the cyclones. Cyclones are used extensively because they are effective and inexpensive, and they require little maintenance.

Cyclones are essentially cylindrical in shape and have a long, conical hopper bottom and a center cylinder through which the air escapes. The trash-laden air enters tangentially near the top. Centrifugal force caused by the whirling action of the trash and air pushes the trash outward and into the conical hopper below. The air passes up and out through the central cylinder.

Cyclones in use at cotton gins today may be classified generally as large-diameter and small-diameter types. Each has its advantages, and both will do a satisfactory job of dust collecting if engineered properly. A comparison of the trash-collecting efficiencies of the large- and small-diameter cyclones is shown in table 17.

TABLE 17.—*Trash-collecting efficiency of large- and small-diameter cyclones*

Cyclone	Air volume [1]	Trash volume [2]	Efficiency
	C.f.m.	*G./min.*	*Pct.*
Large diameter, low pressure:			
Trash exit opened	6, 204	25. 789	79. 73
Trash exit closed	6, 061	29. 127	63. 03
Small diameter, high pressure:			
Trash exit opened	5, 917	20. 241	83. 86
Trash exit closed	5, 767	17. 614	84. 34

[1] Air volume range on small-diameter cyclones: 4,580 to 6,771 c.f.m. Two cyclones used parallel. On large-diameter cyclone: 4,965 to 6,771 c.f.m. One cyclone used.
[2] Trash volume range on small-diameter cyclone: 4.636 to 55.033 g./min. On large-diameter cyclone: 6.847 to 76.268 g./min.

Accurately determining the air volume is most important in installing a cyclone. When it is not possible to accurately measure the air volume (see Fans and Piping, p. 60), it may be estimated, using tables 18 and 19 as guides.

TABLE 18.—*Pipe diameters, areas, and volumes at mean velocity of 4,500 f.p.m.*

Pipe diameter (inches)	Area	Volume
	Sq. in.	*C.f.m.*
5	19. 64	612
6	28. 27	882
7	30. 49	1, 202
8	50. 27	1, 571
9	63. 62	1, 989
10	78. 54	2, 453
11	95. 03	2, 970
12	113. 10	3, 533
13	132. 73	4, 149
14	153. 94	4, 811
15	176. 71	5, 522
16	201. 06	6, 282
18	254. 47	7, 952
20	314. 16	9, 819

TABLE 19.—*Estimated air volume from various sources*

Source of air	Estimated air volume
	C.f.m.
Unloading fan	[1] 1, 250
Driers (or drier-cleaner combinations)	[2] 6, 000
Feeder-driers	[1] 1, 200
10-inch trash line	[3] 2, 200
11-inch trash line	[3] 2, 600
12-inch trash line	[3] 3, 100
13-inch trash line	[3] 3, 700
14-inch trash line	[3] 4, 300

[1] Per gin stand.
[2] Per drier.
[3] Based on 4,000 f.p.m. velocity in pipe.

Large-Diameter Cyclone

After determining the air volume in cubic feet per minute, the size of the large-diameter cyclone needed can be determined as follows:

(1) Vent stack diameter commonly equals half the nominal (outside) cyclone diameter. When given the size of the cyclone and the desired velocity of air through its vent stack, then

(2) Air volume entering cyclone (c.f.m.) equals

$$\frac{\text{vent air velocity (f.p.m.} \times \text{vent diameter}^2 \text{ (ft.}^2\text{))}}{1.273}$$

when given the size of the cyclone and the volume of air that is to enter the cyclone, then

(3) Vent air velocity (f.p.m.) equals

$$\frac{1.273 \times \text{air volume entering cyclone (c.f.m.)}}{\text{vent diameter}^2 \text{ (ft.}^2\text{)}}$$

When given the volume of air that is to enter the cyclone and the desired velocity of air in the vent stack, then

(4) Vent diameter (ft.) × 1.128

$$\sqrt{\frac{\text{air volume entering cyclone (c.f.m.)}}{\text{vent air velocity (f.p.m.)}}}$$

(5) Cyclone diameter (ft.) = vent diameter (ft.) × 2.

A velocity of 600 feet per minute in the vent stack is commonly used for gin trash. For example, a cyclone needed to handle 13,000 cubic feet per minute with a vent velocity of 600 feet per minute would be 10 feet 6 inches in diameter. The dimensions of this and other large-diameter cyclones can be obtained from table 20. The dimensions for large-diameter cyclones are shown in figure 94.

TABLE 20.—*Large diameter cyclone selection table based on a vent velocity of 600 feet per minute*

Air volume (c.f.m.)	Vent diameter	Cyclone diameter
	Ft.-in.	*Ft.-in.*
3,000	2- 6	5- 0
4,000	2-11	5-10
5,000	3- 3	6- 6
6,000	3- 7	7- 2
7,000	3-10	7- 8
8,000	4- 1	8- 2
9,000	4- 4	8- 8
10,000	4- 7	9- 2
11,000	4-10	9- 8
12,000	5- 1	10- 2
13,000	5- 3	10- 6
14,000	5- 5	10-10
15,000	5- 8	11- 4
16,000	5-10	11- 8
17,000	6- 0	12- 0
18,000	6- 2	12- 4

Small-Diameter Cyclone

The proper size small-diameter cyclone is selected much the same as the large-diameter cyclone is selected. However, the small-diameter cyclone requires slightly more horsepower than the large-diameter cyclone (fig. 95), and fans must be able to overcome a pressure drop of 4 to 5 inches of water. Air volume is important and more critical for proper operation of the small-diameter cyclone than for operation of the large-diameter cyclone. The air velocity entering the cyclone must be kept to a minimum of 3,000 feet per minute, and the volume must not be over 4,600 cubic feet per minute. The cyclone may be designed for operating at a higher entrance velocity, provided the system can withstand a greater pressure drop (fig. 96).

The chart in figure 96 can be used to determine cyclone sizes. Cyclone sizes that fall between the heavy dotted lines in the chart provide a good compromise between collection efficiency and horsepower load or pressure drop. These limits are within normal operating conditions for centrifugal fans and for the recommended inlet velocities of 3,000 feet per minute. The higher the inlet velocity, the higher the separating efficiency and the greater the horsepower required to operate the units. For best results, a cyclone should have a pressure drop of 4 to 5 inches, which is within the limits of most centrifugal fans in use at gin plants.

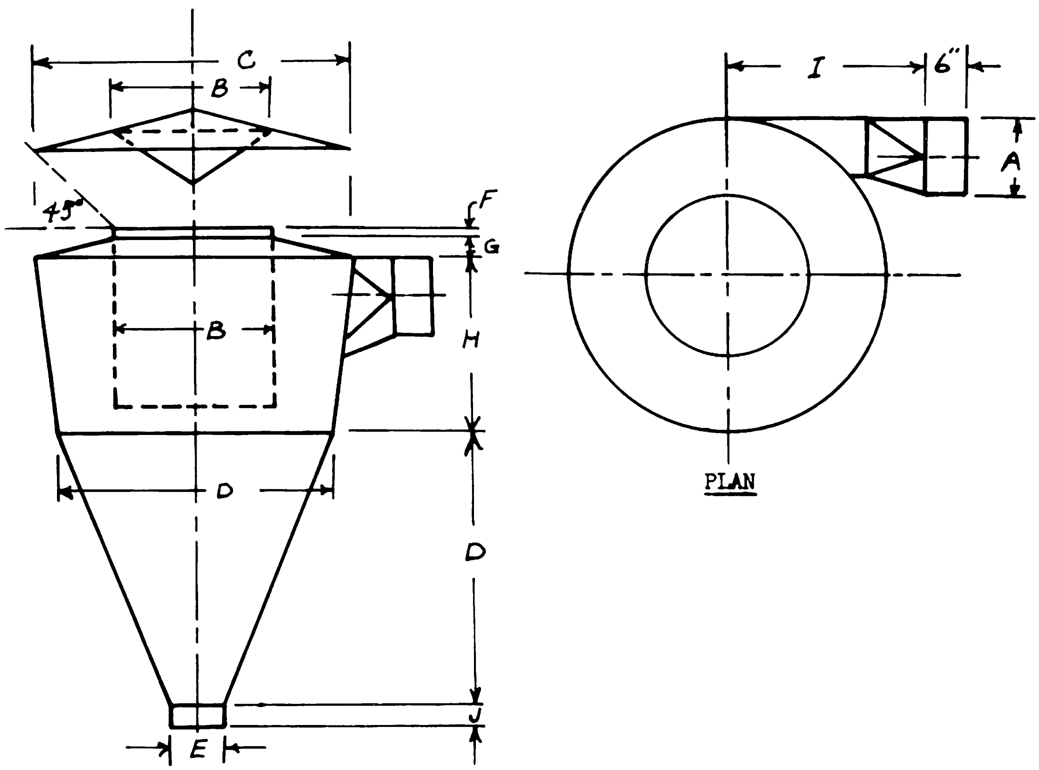
After determining the air volume, the proper size small-diameter cyclone can be selected from figure 96. Should the volume be more than 3,000 cubic feet per minute, two or more cyclones may be used in parallel. Do not attempt to increase the collection efficiency by installing a pair of identical cyclones in series. The collection efficiency of two identical units is no greater than that of one. The number and size of cyclones to use on an installation can be determined from table 21. The symbols used in this table are illustrated in figure 97. It is recommended that the size be selected from the figures above the horizontal lines in table 21. For example an air volume of 2,664 cubic feet per minute would require one 32-inch-diameter cyclone; whereas an air volume of 6,000 cubic feet per minute would require two 34-inch-diameter units mounted parallel. And an air volume of 9,000 cubic feet per minute mounted parallel would require four 29.4-inch diameter units.

An inlet transition for double-mounted, small-diameter cyclones is shown in figure 98. For installations requiring quadruple mounted, small-diameter cyclones, see figure 99. When selecting transitions for multiple-mounted cyclones, avoid sharp edges whenever possible. A rounded edge will shed gin trash, whereas a sharp edge tends to cause trash to lodge.

The small-diameter cyclone and lint fly catcher installation at the U.S. Cotton Ginning Research Laboratory at Stoneville, Miss., is shown in figure 100. Small-diameter cyclones work satisfactorily with an incinerator. Such an installation is shown in figure 101.

Space and height limitations may also be a factor in choosing a multiple mount. A cyclone 4 feet in diameter will be a minimum of 17 feet high, whereas a 2-foot-diameter cyclone will be only 9 feet high. A good rule of thumb in selecting small-diameter cyclones is to keep the diameter less than 34 inches.

DIMENSIONS OF COMMERCIAL TYPE CYCLONE



Dimensions in Inches

A	B	C	D	E	F	G	H	I	J	Wgt.
8	16	32	28	7	3/4	2	18	20	3	125
10	20	40	35	8	3/4	2-1/2	22-1/2	25	3	150
12	24	48	42	8	3/4	3	27	30	4	200
14	28	56	49	8	7/8	3-1/2	31-1/2	35	4	350
16	32	64	56	8	7/8	4	36	40	4	450
18	36	72	63	9	7/8	4-1/2	40-1/2	45	5	565
20	40	80	70	10	1	5	45	50	5	695
22	44	88	77	11	1	5-1/2	49-1/2	55	6	835
24	48	96	84	12	1	6	54	60	6	990
26	52	104	91	13	1	6-1/2	58-1/2	65	6	1150
28	56	112	98	14	1	7	63	70	6	1330
30	60	120	105	15	1-1/8	7-1/2	67-1/2	75	6	1800
32	64	128	112	16	1-1/8	8	72	80	7	2050
34	68	136	119	17	1-1/8	8-1/2	76-1/2	85	7	2310
36	72	144	126	18	1-1/8	9	81	90	7	2580
38	76	152	133	19	1-1/4	9-1/2	85-1/2	95	7	2880
40	80	160	140	20	1-1/4	10	90	100	8	3190
42	84	168	147	21	1-1/4	10-1/2	94-1/2	105	8	3650
44	88	176	154	22	1-1/2	11	99	110	8	3880
46	92	184	161	23	1-1/2	11-1/2	103-1/2	115	8	4240
48	96	192	168	24	1-1/2	12	108	120	8	4610

Sizes 8 to 28 incl. of No. 18 Ga. Galv. Iron
Sizes 30 to 48 incl. of No. 16 Ga. Galv. Iron

Figure 94.—Dimensions for large-diameter cyclone.

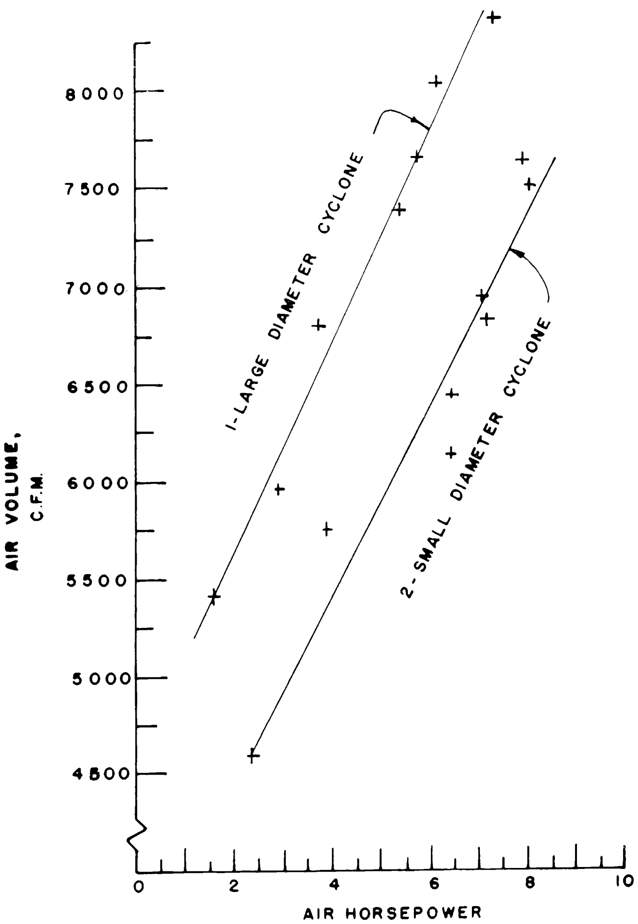


***Figure 95.*—Power requirements—large-diameter and small-diameter cyclones.**

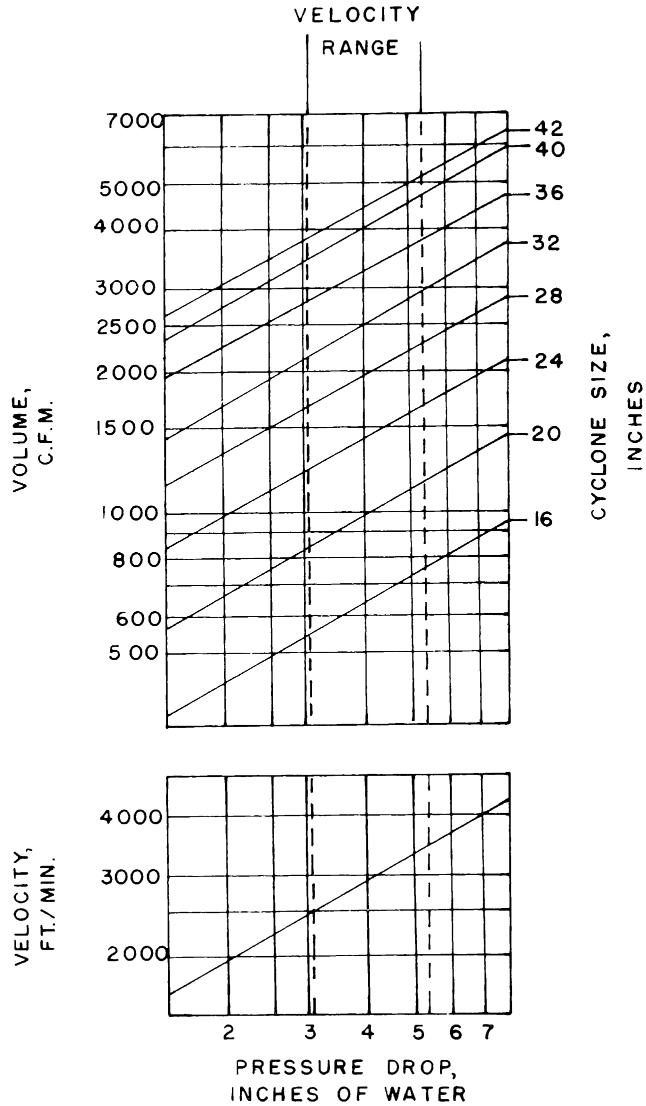


***Figure 96.*—High efficiency cyclone selection chart.**

A straight run of pipe should enter the cyclone to reduce turbulence and provide the best conditions for separation. The straight run should be a minimum of 7 to 10 feet. With multiple mounts, unless the inlet pipe is straight, one of the cyclones may get more trash-laden air than it was designed to handle and may, therefore, not function correctly.

Lint Fly Catchers

A unique wire cage has been effective for collecting lint fly from condenser exhausts. It is nothing more than a cylindrical unit made from 14- to 18-gage screen wire. To operate satisfactorily, it must be kept dry and sized properly. Moisture on the screen area will prevent the units from operating properly. Louvers designed by the U.S. Cotton Ginning Research Laboratory at Stoneville may be attached to the lint catcher and will, except under extreme conditions, prevent moisture from accumulating on the screen. To insure best operation under all conditions, lint fly catchers should be installed in a house where they cannot get wet. If they are so installed, louvers are not necessary.

Moisture causes lint to adhere to the screen wire and creates a back pressure on the condenser exhaust. If the screen is not changed, the pressure will eventually build up and cause chokages in the gin machinery.

Lint fly catchers that are attached to condenser exhausts and protected from the weather and whose outlets are connected to the suction of a fan require little attention for satisfactory operation (fig. 102). Lint catchers that require a bag on the bottom for collecting the lint fly need frequent attention. The bag must be emptied regularly, and occasionally the inside of the lint catcher must be cleaned. Emptying the bag two or three times a day is usually sufficient for satisfactory operation.

When lint fly catchers are installed in a shed, provisions must be made for the air to escape

TABLE 21.—*Dimensions and arrangements for single, double, and quadruple installations of small-diameter cyclones*

Air entering cyclone (C.f.m.)	Cyclone dimensions[1]								
	Single			Double			Quadruple		
	Diameter Dc	Height Lc+Zc	Inlet Bc×Hc	Diameter Dc	Height Lc+Zc	Inlet Bc×Hc	Diameter Dc	Height Lc+Zc	Inlet Bc×Hc
	Inches	*Feet*	*Inches*	*Inches*	*Feet*	*Inches*	*Inches*	*Feet*	*Inches*
666	16. 0	5. 4	4. 0× 8. 0	-	-	-	-	-	-
1, 042	20. 0	6. 8	5. 0×10. 0	-	-	-	-	-	-
1, 500	24. 0	8. 0	6. 0×12. 0	-	-	-	-	-	-
2, 042	28. 0	9. 4	7. 0×14. 0	-	-	-	-	-	-
2, 664	32. 0	10. 8	8. 0×16. 0	-	-	-	-	-	-
3, 000	34. 0	11. 3	8. 5×17. 0	24. 0	8. 0	6. 0×12. 0	17. 0	5. 7	4. 25× 8. 5
4, 000	39. 2	13. 1	9. 8×19. 6	27. 6	9. 2	6. 9×13. 8	19. 6	6. 5	4. 90× 9. 8
5, 000	44. 0	14. 7	11. 0×22. 0	31. 2	10. 4	7. 8×15. 6	22. 0	7. 3	5. 50×11. 0
6, 000	48. 0	16. 0	12. 0×24. 0	34. 0	11. 3	8. 5×17. 0	24. 0	8. 0	6. 00×12. 0
7, 000	52. 0	17. 3	13. 0×26. 0	36. 8	12. 3	9. 2×18. 4	26. 0	8. 7	6. 50×13. 0
8, 000	56. 0	18. 7	14. 0×28. 0	39. 6	13. 2	9. 9×19. 8	28. 0	9. 3	7. 00×14. 0
9, 000	58. 8	19. 6	14. 7×29. 4	41. 6	13. 9	10. 4×20. 8	29. 4	9. 8	7. 40×14. 7
10, 000	62. 0	20. 7	15. 5×31. 0	43. 6	14. 5	10. 9×21. 8	31. 0	10. 3	7. 75×15. 5
11, 000	64. 8	21. 6	16. 2×32. 4	45. 6	15. 2	11. 4×22. 8	32. 4	10. 8	8. 10×16. 2
12, 000	68. 0	22. 7	17. 0×34. 0	48. 0	16. 0	12. 0×24. 0	34. 0	11. 3	8. 50×17. 0

[1] Dc=Diameter cyclone; Lc=Length of cyclone cylinder; Zc=Length of cyclone cone; Bc=Width of inlet duct; Hc=Height of duct. (See fig. 97.)

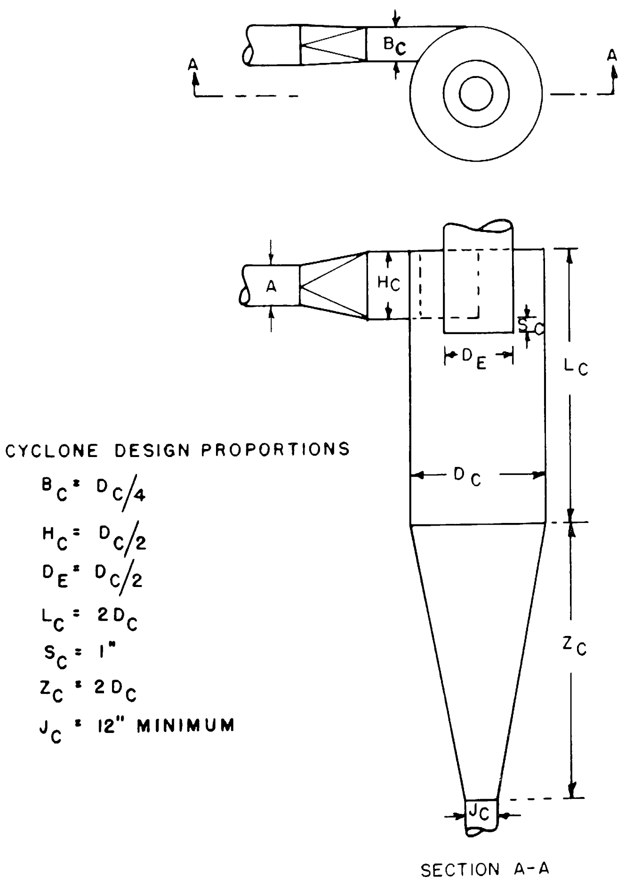


Figure 97.—**Illustrated standardized cyclone symbols.**

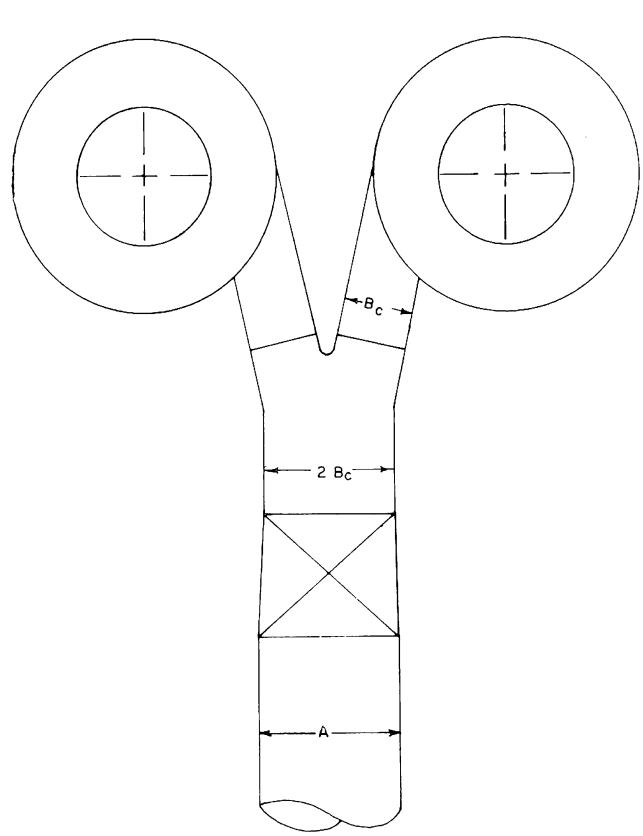


Figure 98.—**Inlet transition designed for double-mounted small-diameter cyclones. (See table 21.)**

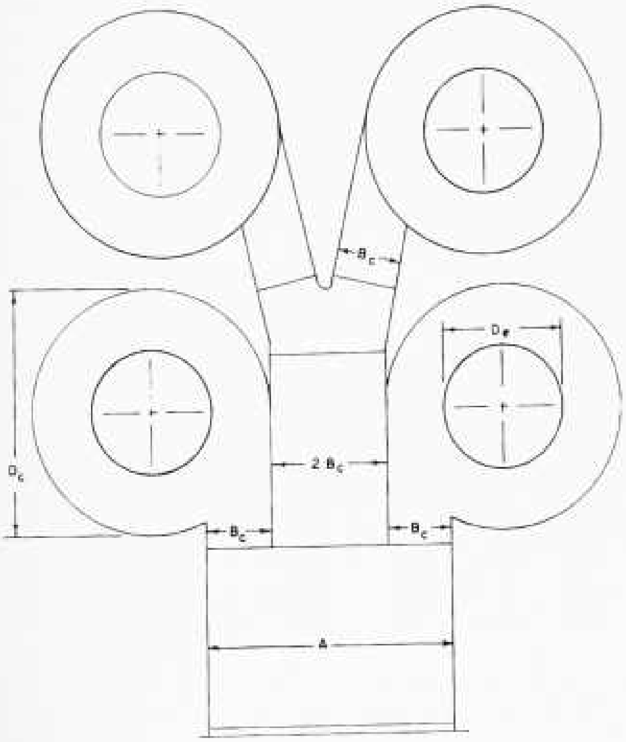


Figure 99.—Inlet transition designed for quadruple-mounted small-diameter cyclones. (See table 21.)

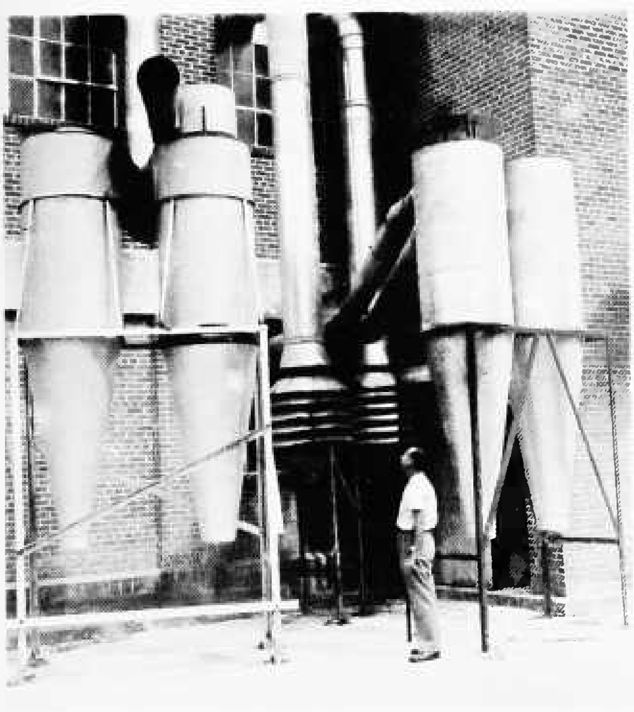


Figure 100.—Small-diameter cyclone and lint fly catcher installation.

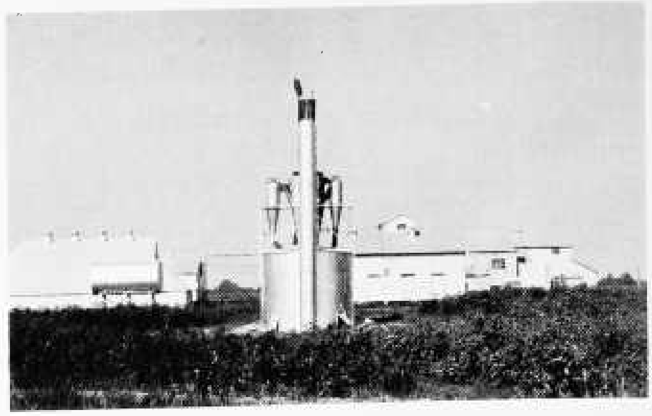


Figure 101.—Small-diameter cyclones installed over an incinerator.

from the shed, so that pressure will not build up. The open space between the lint catchers and any obstacle should be not less than 18 inches.

The size of lint catcher to use depends on air volumes and pressures in the pipe. For satisfactory operation, the air volume should be measured accurately if possible. When measurements cannot be made, the manufacturer of the equipment should be able to provide this information. A handy rule to follow in estimating the air volume from condensers connected to gin stand lint flues is to allow a volume of 1,300 cubic feet per minute per 100 gin saws in the battery. This rule may not be accurate on the second condenser of tandem installations or on installations where air is induced into the system. However, for most gin work, the rule is sufficiently accurate to give satisfactory results.

The proper size of lint catcher for a given air volume is shown in table 22. These data are based on there being an axial fan installed between the condenser and lint fly catcher. On installations where a catcher is needed on a condenser that does not have a fan, a unit 72 inches in diameter by 96 inches long should be used (fig. 102).

TABLE 22.—*Selection table for lint fly catchers*

Air volume (c.f.m.)	Lint fly catcher	
	Diameter	Length
	Inches	*Inches*
3,000	36	48
4,000	42	48
5,000	42	60
6,000	42	72
7,000	45	72
8,000	48	72
9,000	48	84
10,000	50	84
11,000	53	84

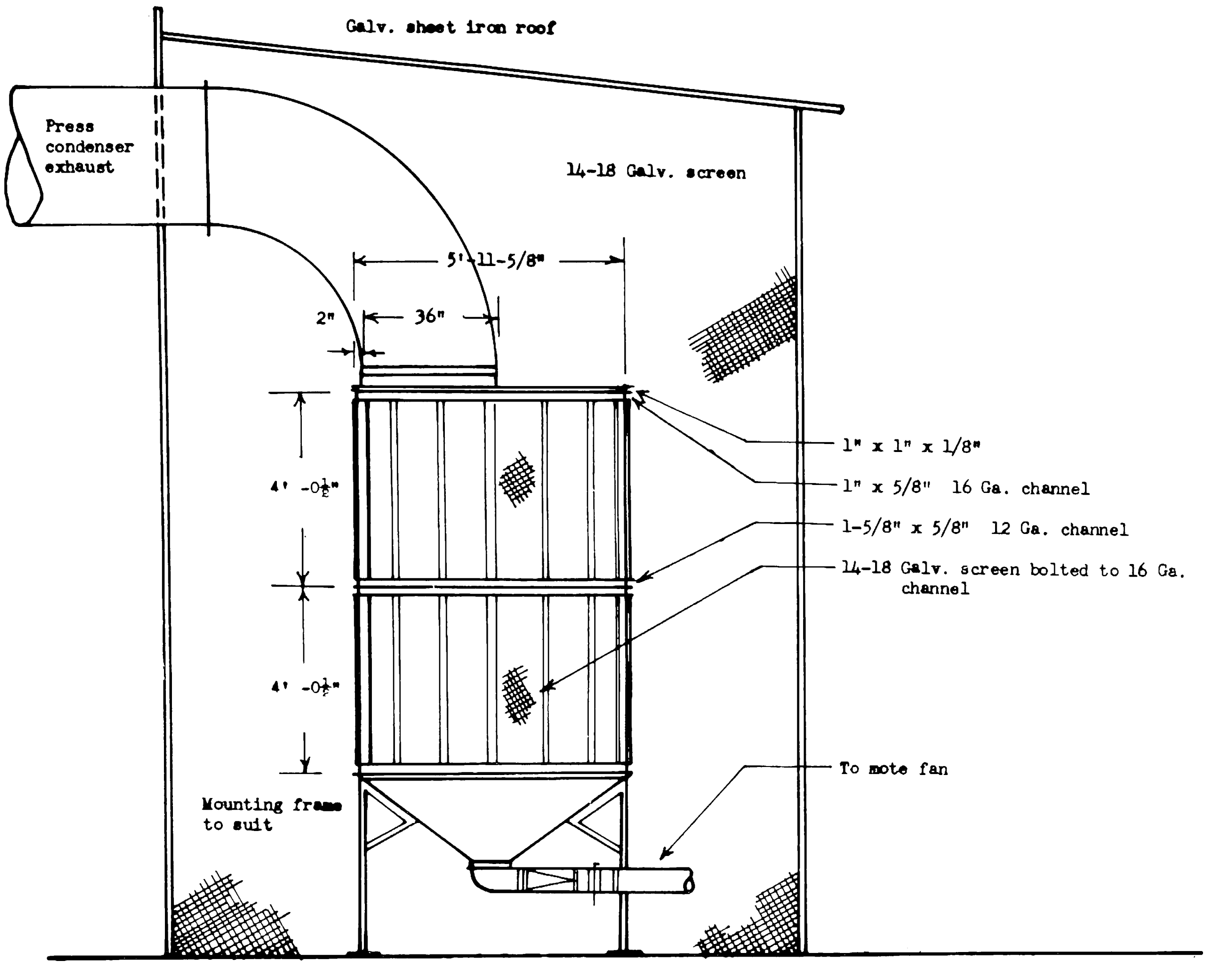


Figure 102.—Lint fly catcher installation.

A diagram of a 36-inch lint fly catcher without louvers is illustrated in figure 103, and a unit with louvers installed is shown in figure 104.

A system for collecting and disposing of gin trash is shown in figure 105. There are numerous equally good variations of lint catchers for collecting trash from the gin and conveying it to incinerators or large trash hoppers for disposal. When lint catchers are attached to an air line, a slide valve should be installed under the unit to regulate air flow.

Settling Chamber

Collecting cotton gin trash by cyclones and lint fly catchers is the most satisfactory method to use. However, some gins are using dust houses or settling chambers with success. These are used in areas where space is no problem and the dangers of air pollution are not great.

Settling chambers must be large enough and so designed to prevent small trash particles from being carried into the atmosphere by air currents. Velocities of air at the outlet should be less than 75 feet per minute. The correct dimensions for handling different volumes of incoming air are shown in figure 106.

Much is yet to be learned about trash collecting and operating cyclones and lint collectors. Careful attention must be given to details, and the system must often be adjusted to make the units operate properly. However, the various systems described will work if properly engineered. At best, collecting trash is difficult and expensive. Numerous devices are tried from time to time, and some of them are working satisfactorily. If trash-collecting equipment is satisfactory, there is no reason to change it.

DISPOSING OF GIN WASTE

By V. P. Moore, E. A. Harrell, and D. M. Alberson, *cotton technologist and agricultural engineers, respectively, Agricultural Engineering Research Division, Agricultural Research Service*

Incinerators

Safe disposal of gin trash creates a major problem, especially in areas where there are 500 to 1,000 pounds of extraneous materials to every bale

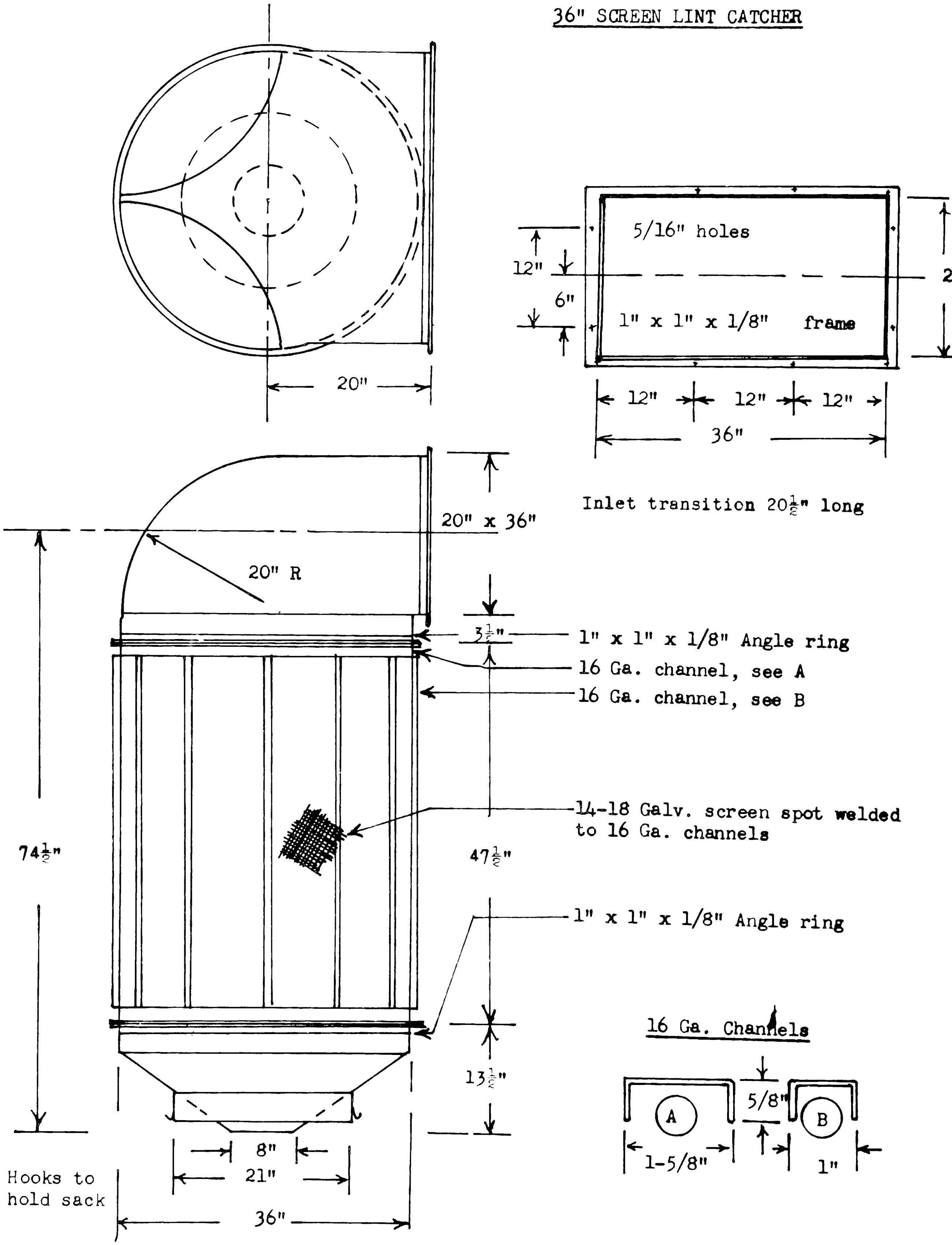


Figure 103.—Lint fly catcher installation without louvers.

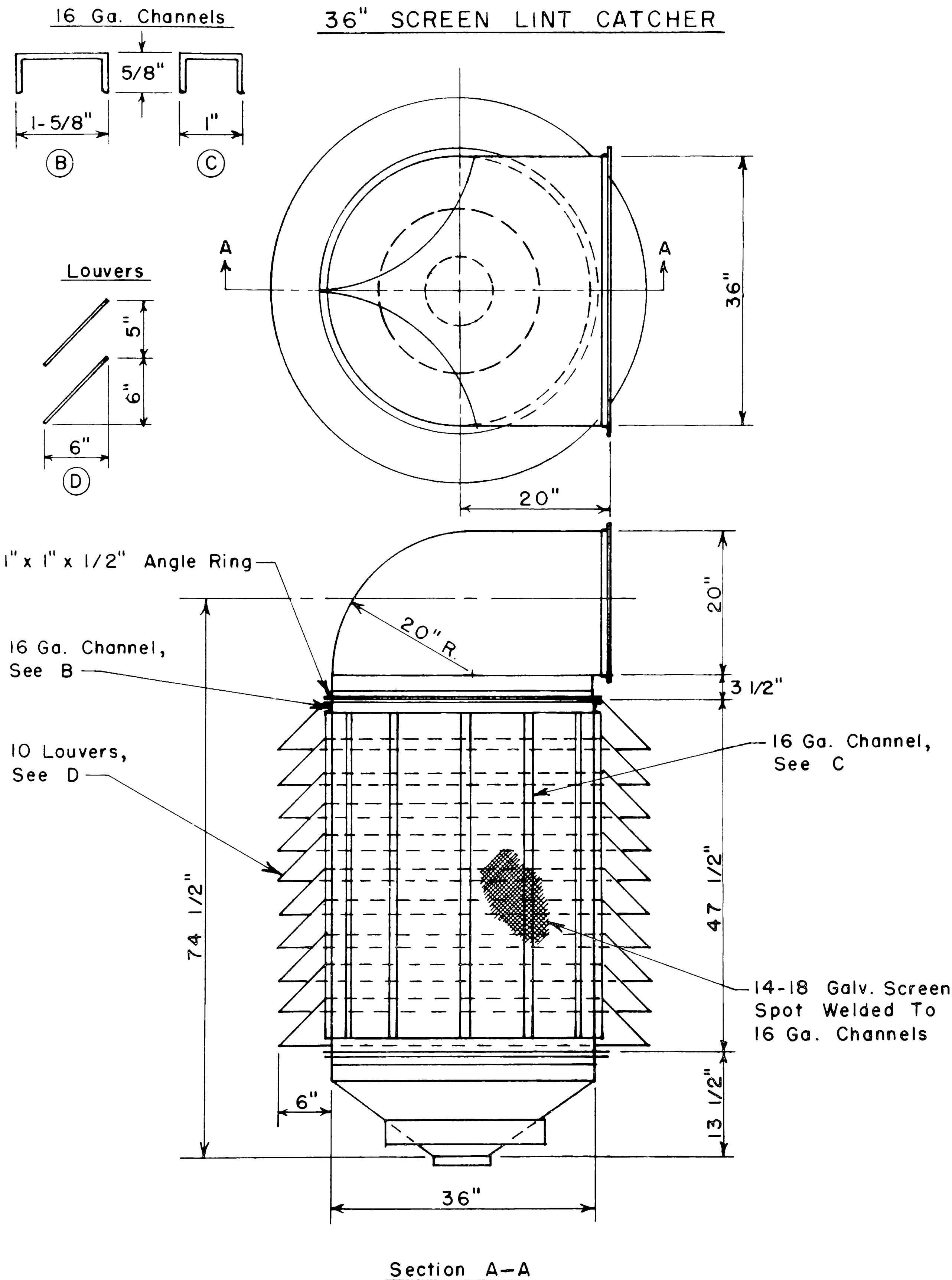


Figure 104.—Lint fly catcher installation with louvers.

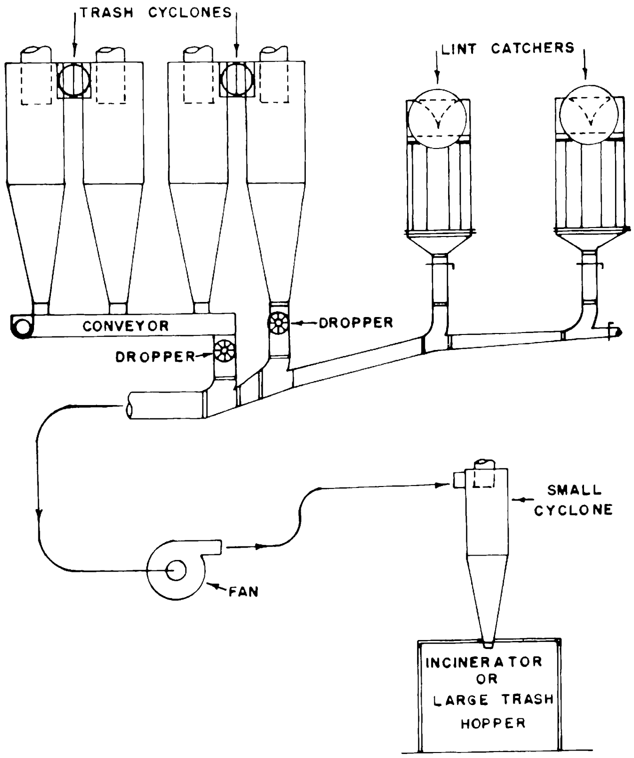


***Figure 105.*—Gin trash collection and disposal system.**

ginned. Several means are available for disposing of gin trash. Each has some merits in certain areas. The trash may be composted, applied directly to the soil either horizontally or in a vertical mulch, fed to livestock, or burned.

Burning gin trash is hazardous and is hard to control. The trash tends to smoke and smoulder a long time. In areas where it is burned, some gins improvise incinerators. Trash should not be burned within 200 feet of any building on the premises. The prevailing wind direction should be considered when selecting an incinerator site, so that the incinerator may be placed downwind to prevent smoke, sparks, or ash from creating a fire hazard or a nuisance in the area. All incinerator openings should be covered by heavy-duty fire screen that has a maximum of one-half-inch mesh.

The locality will, in most instances, determine the type of incinerator to use. In areas where space is unlimited, the open pit type would probably be satisfactory. In areas where space is limited, an aboveground type made from steel plate, brick, or adobe will be the best incinerator to use.

Incinerator size depends on the capacity of the gin, the amount of cotton ginned, and the type of trash to be burned. A steel-plated unit, 20 feet in diameter by 20 feet high, will have adequate capacity to handle a 4–80 or 5–80 plant. Plants with 3–80 saw stands and smaller can obtain the same burning efficiency by using a 16-foot-diameter by 16-foot-high incinerator. Ginning plants of the 5–90 size, or those ginning 8 to 10 bales per hour of machine-picked cotton, should use an incinerator 25 feet in diameter by 20 feet high.

Several types of incinerators are used by the ginning industry. The pit type is good, so far as burning the trash is concerned. The pit should be deep and wide enough to take care of a year's ginning, since it cannot be cleaned out during the ginning season. For this reason, incinerators built aboveground are much more satisfactory. The aboveground units can be cleaned any time during the ginning season.

A typical steel-plated incinerator lined with brick is shown in figure 107. Trash is blown into the incinerator through two 8-inch lines placed just below the base of the roof and directed against buffer plates. Specifications for this type incinerator, which may be altered to suit conditions, are given as follows:

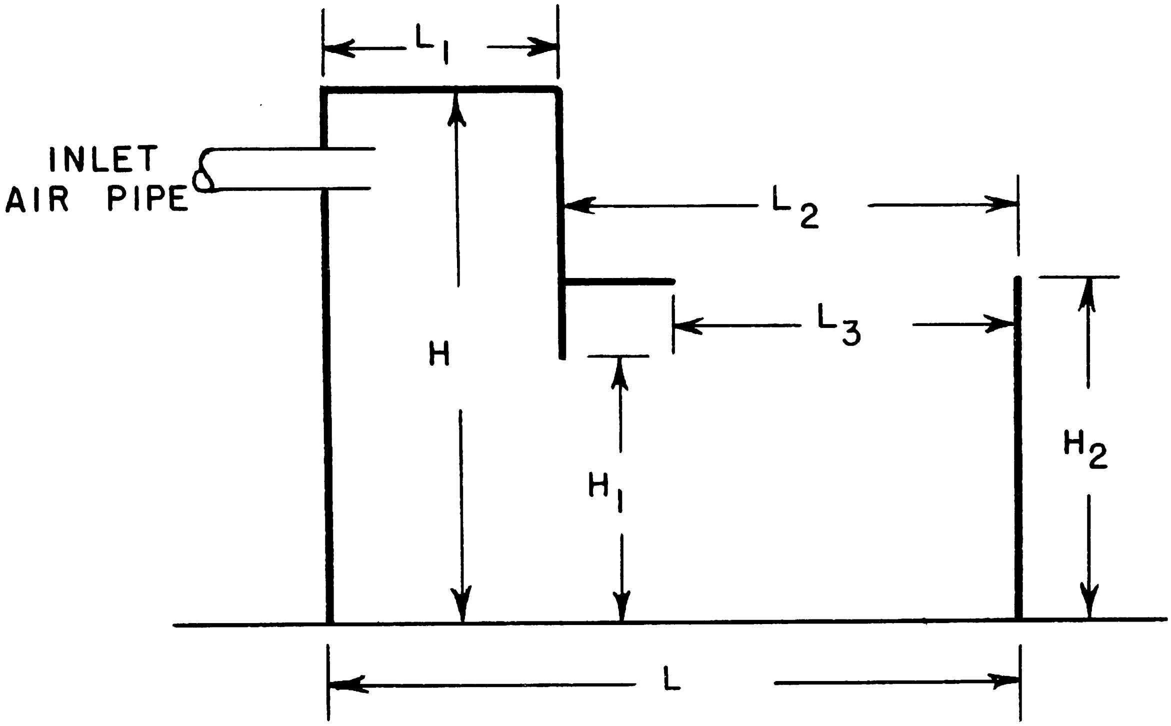
Specifications for Steel-plated Incinerator

Pit depth—30 inches
Pit diameter—20 feet
Incinerator height—20 feet
Incinerator diameter—20 feet
Incinerator walls—sheet metal, same gage as that used in boiler stacks
Incinerator roof—sheet metal, same as that used in walls (coned)
Incinerator foundation—brick supported on outside by concrete
Incinerator lining—common brick, 1-layer thick, longways to metal
Height of incinerator lining—6 feet aboveground level
Incinerator foundation lining—common brick, 1-layer thick, endways
Ventilation—1-brick space every 2 feet at top of foundation, 26-inch air release at top of coned roof covered with screen
Door—2 feet by 3 feet near base
Stack—26-inch, on concrete base, 3 feet from incinerator, 30 feet high (approximately)
T-joint leading from incinerator to stack—26 inches, about 3 feet below top of incinerator wall

Although the height of the stack shown is 30 feet, this is the minimum height recommended. To further reduce the smoke hazard, the height of the stack should be increased.

In areas where adobe blocks can be obtained, these may be used instead of brick. When rainfall is not so great during the ginning season, adobe-block incinerators may be built with open tops and with straight, perpendicular walls of any height or inside diameter desired.

Another type of incinerator (fig. 108) that has proved efficient for burning gin trash is the square unit with stack built over a pit in the ground.



Air entering settling chamber (c.f.m.)	Settling chamber dimensions							
	H	H_1	H_2	L	L_1	L_2	L_3	Width
	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.	Ft.
10,000	12	6	9	18	6	12	7-1/2	18
15,000	15-1/2	7-3/4	9-3/4	19-1/2	6-1/2	13	10-1/4	19-1/2
20,000	18	9	11-1/4	22-1/2	7-1/2	15	12	22-1/2
25,000	20	10	12-3/4	25-1/2	8-1/2	17	13-1/4	25-1/2
30,000	22	11	13-7/8	27-3/4	9-1/4	18-1/2	14-3/4	27-3/4
35,000	23-1/2	11-3/4	15	30	10	20	15-1/2	30
40,000	25-1/2	12-3/4	15-3/4	31-1/2	10-1/2	21	17	31-1/2
45,000	27-1/2	13-3/4	16-1/2	33-1/2	11	22	18-1/4	33
50,000	28	14	18	36	12	24	18-1/2	36

Air inlet pipes should be kept well above lower edge of baffle. Dimension H_1 should be large enough to insure that the air velocity into the outer chamber will be less than 100 f.p.m. Dimension L_3 should be large enough to insure that the outlet air velocity will be less than 75 f.p.m.

Figure 106.—Cotton gin dust settling chamber design and dimensions.

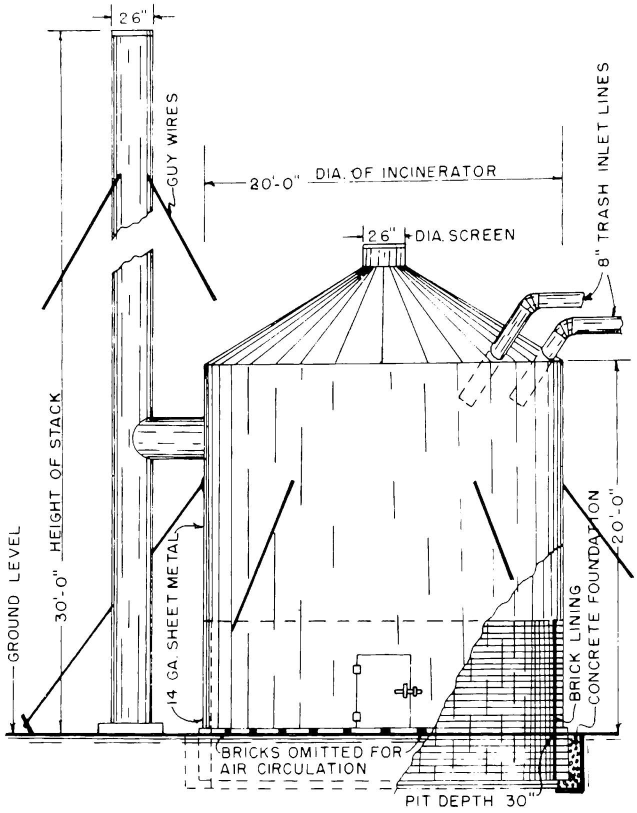


Figure 107.—**Boiler plate brick-lined incinerator.**

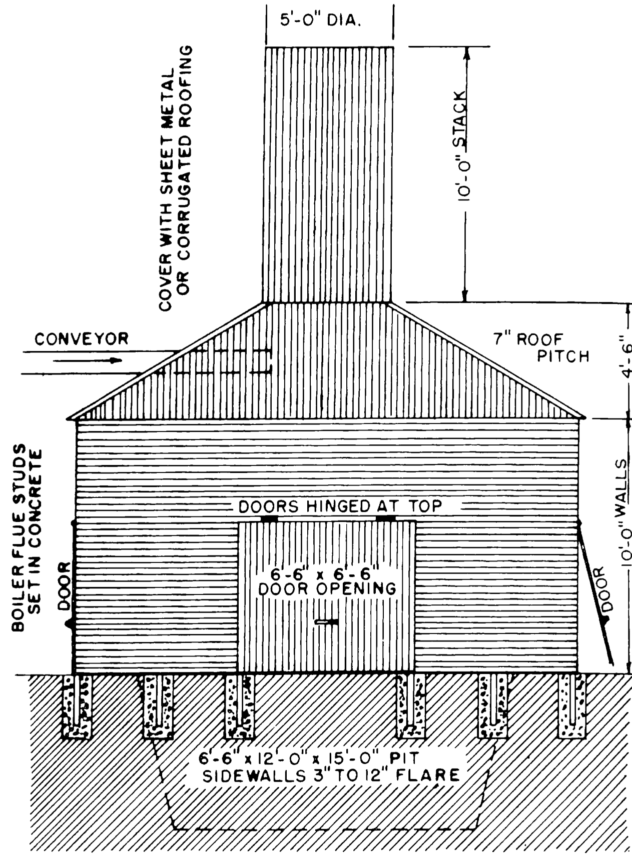


Figure 108.—**Incinerator built over pit in ground.**

Illustrated in figure 109 is the jug-type incinerator, which is used satisfactorily in areas where smoke is not objectionable.

In burning trash, best results are obtained when sand and earth are removed from the trash before it is placed in the incinerator.

An iron-plated, brick-lined incinerator (fig. 110) is used in the Midsouth area with good result. This unit is 25 feet in diameter by 16 feet high and has adequate capacity for 5–90 saw gins. The walls, top, and stack are constructed of 10-gage, black iron with two rows of brick lining the wall to a height of 12 feet. The inside row is made of firebrick, and common brick is used to make the outer row. An air space of 2 inches is provided between the metal wall and the outer row of common brick for insulating the metal. The stack of this unit is 48 feet high and is equipped at the top with a 4-foot, heavy screen spark arrester.

The top of this incinerator is an excellent place to install small-diameter cyclones. They may be placed on the top anywhere convenient for adequately spreading the trash over the burning area. This method of depositing trash into incinerators eliminates many problems resulting from air turbulence.

Composting

Gin trash, consisting of leaf particles, burs, stems, motes, and other extraneous organic materials, can be decomposed on the gin yard as compost. Sufficient water should be added to raise the moisture content of the material to approximately 75 percent, and the rate of decomposition may be increased by aeration. Microbial life and many chemical reactions are conditioned by the presence of water and air. A great deal of heat is generated in the process. Sufficient moisture must be maintained; if the material becomes dry, decomposition will stop. On the other hand, too much water excludes air from the micro-organisms and also causes waste through leaching and runoff.

Outdoor bins (walls only) and trenches have been used for compost heaps. The piles, bins, or trenches should not be over 4 to 6 feet deep to allow for aeration.

Research to study the effects of additives on the rate of decomposition showed no advantages from adding commercial fertilizers or commercially prepared micro-organisms. The gin trash contained sufficient micro-organisms necessary for decomposition.

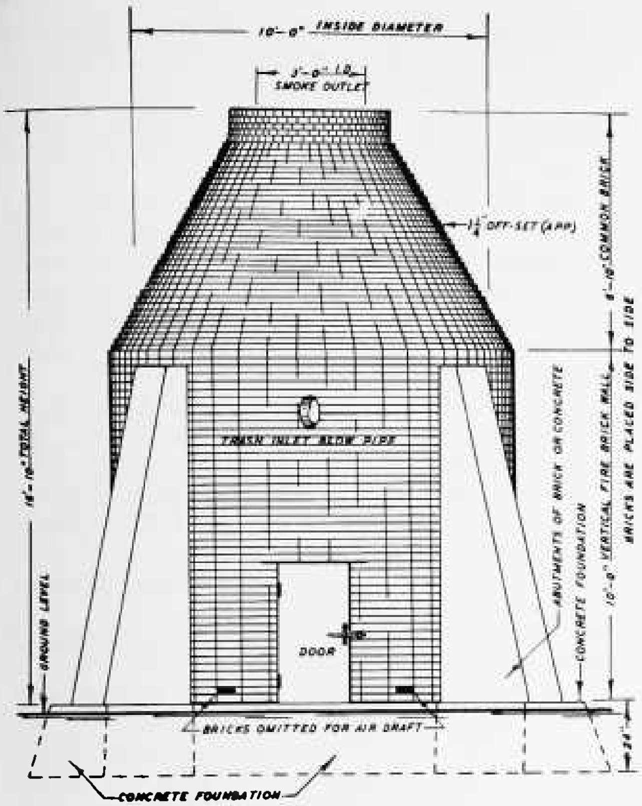


Figure 109.—**Jug-type incinerator.**

Figure 110.—**Incinerator with small-diameter cyclones on top in use near Stoneville, Miss.**

Research findings showed that properly composted gin trash, compared with raw gin trash, was relatively free of disease and weed seeds. Thus, it is safer to return compost to cotton fields than it is to return raw trash. Cotton producers usually obtain compost at a nominal fee and haul it to their fields. However, gin trash is composted at only a few gins located in the Southwest.

Temperature measurements read periodically inside the material indicate the progress in decomposition. Figure 111 shows the rapid rise in temperature of a compost to approximately 140° F. the first 4 or 5 days, then a leveling off and gradual decline in temperature for a few weeks.

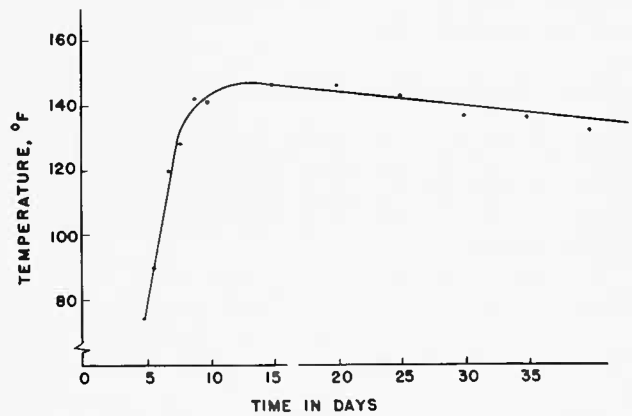


Figure 111.—**Changes in temperatures of gin trash in compost piles (averages of four similar treatments, Southwestern Cotton Ginning Research Laboratory, 1954).**

The principles of composting, as stated above, should be observed in adapting methods at particular gins.

Livestock Feed

The physical and chemical properties of gin trash vary; but, in general, this bulky material is of low value as a livestock feed and has no market value. However, in a summary study of feeding trials made at the El Paso Valley Experiment Station, Ysleta, Texas, gin trash is listed at $12.50 per ton, along with cottonseed hulls at $25 per ton. Use of the trash as a feed depends on the availability of other roughage. As feed, it is useful only to a limited extent.

Soil Application

In the plains area of Texas and in some locations in the Southwest and the West, soil application of gin trash is a general practice. The trash is hauled from the gin with specially built trailers or spreaders and is applied to the ground surface at the rate of several tons per acre.

PINK BOLLWORM IN GIN WASTE

By V. L. STEDRONSKY, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

Some cotton areas of the United States are infested with pink bollworms. In these areas the U.S. Department of Agriculture, cooperating with State Departments of Agriculture, requires that certain quarantine regulations be observed. These regulations pertain to the movement of cotton and cottonseed and the byproducts thereof within regulated areas and from infested areas to noninfested areas. Oil mills, producers, and ginners are affected by these regulations. Only those regulations pertaining to the treatment of gin trash will be discussed here.

Areas Under Pink Bollworm Quarantine

As of January 29, 1963, Title 7, Chapter III, Part 301, paragraph 301.52–2a of the U.S. Department of Agriculture Pink Bollworm Quarantine Regulations, the following were designated as regulated areas:

Arizona: Counties of Cochise, Gila, Graham, Greenlee, Maricopa, Pima, Pinal, and Santa Cruz.

Arkansas: All or parts of the following counties: Cleburne (portion lying south of the South Fork of the Little Red River), Conway, Crawford, Faulkner, Hempstead, Sebastian, Van Buren, and White (portion lying south and west of South Fork of the Little Red River and northwest of the Missouri Pacific Railway).

Louisiana: Parishes of Bossier, Caddo, De Soto, Natchitoches, Red River, and Sabine.

New Mexico: All counties in the State.

Oklahoma: All counties in the State.

Texas: All counties in the State.

Cotton ginners are mostly affected by the quarantine regulations in the handling of seed and the disposal of gin trash.

Cottonseed.—In general, cottonseed can move freely to oil mills within the regulated area without treatment. Research on killing pink bollworms in the modern cotton gin and on killing caused by oil mill processing or by planting-seed treatments has led to abolishing regulations requiring the heat treatment of cottonseed at gins. Under present practices, the low survival rate of pink bollworms in seed at cotton gins is believed to be of little importance when the seed is used within the generally infested area.

In a few isolated areas in Arkansas and Louisiana, the heat treatment of planting-seed at gins is still required before returning the seed to the farms for storage.

If seed is moved outside the regulated area, it must be treated by the hot-water treatment, by dry-heat sterilization, or by fumigation.

Gin trash.—The ginner is definitely affected by quarantine regulations in disposing of gin trash. Several approved methods of disposal—composting, fumigation, sterilization, hammer milling, incineration, and the single-fan treatment—may be used.

Trash incinerators of various types have long been the most common method of trash disposal in regulated areas. Although many are still used, the trend has been to use the single-fan treatment method, especially in those areas where the trash is returned to the land for soil building or where it is used as livestock feed.

Research has shown that if gin trash is passed through the wheel of a conventional trash fan operating according to conditions specified under the Pink Bollworm Quarantine Regulations, the shock action will destroy all the worms therein (*11*). These specified conditions are:

(1) No fan shall be used with a wheel diameter of less than 19 inches.

(2) The housing or scroll shall be constructed of plate steel or cast iron.

(3) Patching of housing shall be by approved welding methods or plate or cast insertions. No patching shall be done with belting, sacks, rubber, or any other shock absorbing substance, but the fan housing or scroll and piping elbows may be lined with rubber if desired.

(4) No gin trash fan wheel shall be used in an oversized casing, but oversized or standard wheels may be used in standard casings only.

(5) The wheel must be laterally centered to have equal clearance front and back.

(6) Gin fan trash wheels shall be of standard straight blade construction, having not less than six full blades.

(7) Trash must enter at a 90-degree angle to the fan wheel. This may be accomplished by the use of either a straight inlet pipe or a 90-degree elbow; however, previously approved banjo type elbows and adapters are acceptable.

(8) Fan wheel speeds shall comply with the speeds in table 23.

(9) In the event that the inlet pipe is smaller in diameter than the fan housing inlet, the same pipe size should be maintained to the fan housing and protrude inside as shown in figure 112. Tapered cone inlet adapter for pipe connections to fan should not be used, unless the inlet pipe is larger in diameter than the fan housing inlet.

WARNING: Engineering research indicates that tip speed of gin trash fans should never exceed 15,000 feet per minute for safety of life, limb, and equipment.

Lint cleaner waste.—Lint cleaner waste from saw-type lint cleaners is not considered to be the same as gin trash and does not require any special treatment to meet the quarantine requirements.

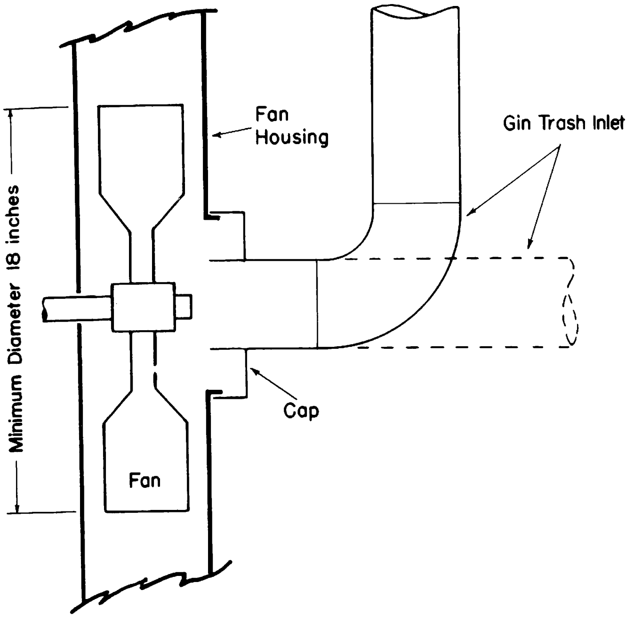


Figure 112.—**Approved fan inlet connections.**

Research has shown that no pink bollworms survive in lint cleaner waste produced from lint cotton after it has passed through one or more saw-type lint cleaners.

Only the essential information on Quarantine Regulations has been discussed here. The regulations vary from State to State and from area to area. They are also changed from time to time. For complete information, consult the Plant Pest Control Division, Agricultural Research Service, U.S. Department of Agriculture, Washington, D.C., 20250, or your local State Plant Pest Control Supervisor.

TABLE 23.—*Federal pink bollworm quarantine requirements regarding wheel diameter, inlet size, and speed of operation of single fans for treating gin trash*

Fan wheel diameter (inches)	Maximum inlet size (inches)	Minimum speed	Maximum safe speed
		R.p.m.	*R.p.m.*
19		2,760	3,020
19½	10 to 10½	2,690	2,940
20		2,620	2,860
20½		2,560	2,790
21		2,490	2,730
21½	10½ to 11	2,430	2,660
22		2,380	2,610
22½		2,330	2,550
23		2,280	2,490
23½		2,230	2,440
24		2,180	2,390
24½		2,140	2,340
25	11½ to 12	2,090	2,290
25½		2,100	2,250
26		2,060	2,200
26½		2,020	2,160
27		1,980	2,120
27½		1,940	2,080
28		1,910	2,050
28½		1,880	2,010
29		1,840	1,980
29½	12 to 12½	1,810	1,940
30		1,790	1,910
30½		1,750	1,880
31		1,725	1,850
31½		1,700	1,825
32		1,700	1,790
32½		1,700	1,760

Auxiliary Equipment

GREEN-BOLL TRAPS

By W. E. Taylor, *agricultural engineer, Oklahoma Cotton Research Station, Chickasha, Oklahoma*

A troublesome ginning problem resulting from the use of mechanical cotton strippers is the presence of green bolls in the harvested material. When green, unopened cotton bolls enter the cotton gin along with mature bolls, many of the green bolls are broken by the first machine they pass through, usually a screen cleaner. Some of the green-boll segments eventually enter the gin stand along with mature locks. When the gin saw teeth engage the wet lint and the soft seed of a green boll, some of the immature material becomes so tightly wedged in the saw teeth that they resist doffing. As the flow of immature locks into the seed roll continues, additional saw teeth become clogged and eventually the seed roll can no longer rotate. As a result, the gin is shut down and the wet material wedged in the saw teeth must be removed by hand.

Various devices are used in cotton gins to remove green bolls from the harvested material and to prevent their reaching the gin stand. Some of these "green-boll traps" are constructed on the principle that green, unopened bolls have a considerably greater specific weight than do dry, mature bolls. In most pipes conveying seed cotton in the gin, the air velocity is such that both open and green bolls will be transported. Since the specific weight of the two types of bolls is different, their separation from each other could be effected in a partial stilling chamber where the air velocity is reduced to such a point that green bolls settle out of the air stream but open bolls do not.

Another principle used is that of centrifugal force. Green bolls are heavier than mature bolls, and since the centrifugal force that might act on an object is proportional to its weight, the two types of bolls could be separated by subjecting them to an equal degree of angular acceleration. The mixture of open and green bolls is conveyed through a duct that abruptly changes direction. Being lighter in weight than green bolls, the open bolls are subjected to less centrifugal force and more nearly follow the path of the air as the duct changes direction. The green bolls tend to continue in the original direction of travel and are thus expelled from the air stream into a suitable collection chamber.

Some commercial models of green-boll traps employ a combination of stilling chamber and centrifugal force (fig. 113). Because of the variation in design of this type of green-boll trap, detailed instructions for its operation cannot be given here. For successful operation, the manufacturer's recommendations for air velocity and baffle adjustment should be closely followed. The trap should be inspected frequently to see that the baffle is properly adjusted for the type of cotton being processed.

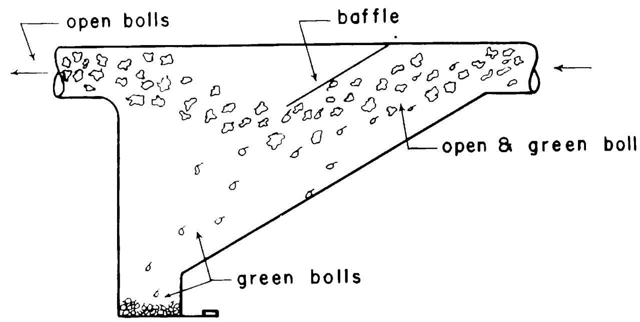


Figure 113.—**Conventional green-boll trap.**

A green-boll trap developed by the USDA is shown in figure 114 (*4*). This trap is normally installed at the discharge from the tower drier, since the cotton is in a relatively thin batt at that point. To insure proper operation of this trap, an air velocity of 1,500 feet per minute should be maintained at the zone of separation. Abrupt turns in the cotton line between the drier and the boll trap should be avoided to prevent chokage. The adjustable baffle can be regulated to accommodate different conditions of green-boll contents and sizes, and it can be closed when it is desired to bypass the trap.

With present green-boll traps, complete separation of green and open bolls is seldom obtained. The efficiency of most traps decreases as the size of green bolls decreases and as the content of green bolls increases. Attempts to remove more green bolls usually result in too high a loss of open bolls in the traps. The open bolls stray from the air stream into the dead air and settle out with the green bolls. An attempt to reclaim the stray open bolls is often made by bleeding air into the air stream through the stilling chamber or the green-boll collection compartment. Since many boll traps are in the wagon suction line, this attempt at reclaiming has the disadvantage of reducing the suction available for unloading cotton from the wagon.

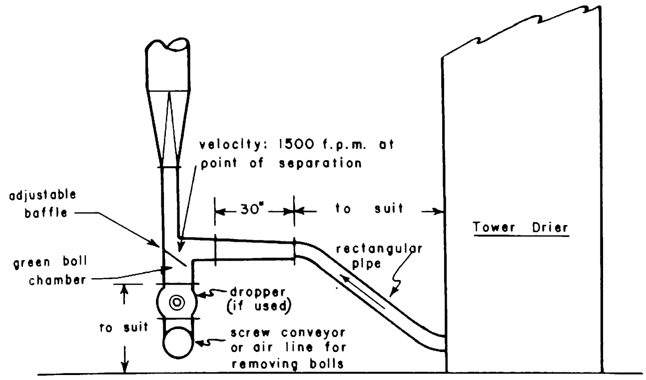


Figure 114.—**USDA green-boll trap.**

Research to develop more effective green-boll traps is underway by both public and private agencies. Research at the cotton ginning laboratories has recently led to the development of an effective trap, but further research will be necessary to reduce the amount of power and accessory equipment needed to use it. With this trap (fig. 115), a thin layer of the harvested cotton is deposited on a moving endless belt. A suction duct positioned near one end of the trap lifts open bolls from the layer of material, while the green bolls, tramp iron, rocks, and clods remain on the belt and are discharged over the end. A large number of sticks and bollies are also removed by this trap. This trap removes from 87 to 92 percent of green bolls, with a lint loss of less than one-fourth pound per bale when used with cotton containing up to 11 percent of green bolls.

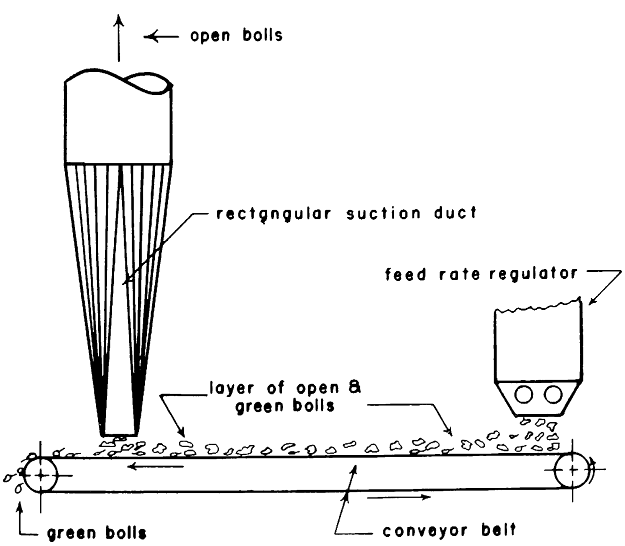


Figure 115.—**Experimental green-boll trap.**

Research is being continued at the cotton ginning laboratories to develop green-boll-removing devices that do not require air bleeds or appreciable quantities of power and accessory equipment.

Green-boll traps should be located as early in the ginning sequence as possible to prevent green bolls from being broken in seed cotton cleaning machinery. Once they are broken or segmented, their aerodynamic properties are undesirably altered, and their removal becomes much more difficult in pneumatic devices. In this respect, the wagon suction line is the most nearly ideal location for the boll trap. However, efficient operation of green-boll traps requires a thin, uniform layer of cotton that is not present in wagon suction lines. For this reason, some types of boll traps are positioned immediately following the tower drier, from which the cotton exits in a thin, wide layer. Placing the traps in this position, however, may not increase green-boll removal because of the breakage occurring within the tower drier.

The breakage of green bolls within the cotton stripper also makes their removal more difficult. No effective method is presently available for removing green bolls delivered to the gin in this condition. The producer and the ginner should attempt to maintain the green bolls intact until such time as they are removed by a boll trap.

Green-boll traps installed in the wagon suction line should be provided adequate space to permit the uniform distribution of the cotton across the width of the trap. With some traps, this may require as much as 3 feet between the suction pipe and the trap proper. In addition, clump breaks and spreaders may be necessary within the transition space. Cotton should flow into the trap at a uniform rate, and the trap should be adjusted for maximum efficiency at that rate.

Most green-boll traps also remove some bollies from the harvested cotton, if any are present. If the harvested cotton contains a large percentage of bollies that are to be ginned along with the open bolls, the boll trap must contain a bypass.

Material removed by green-boll traps can be disposed of as gin trash, or it can be returned to the farm for natural drying. After it is dried and returned to the gin, several pounds of low-quality lint can often be obtained from these green bolls.

MOISTURE METERS

By C. G. Leonard, *physicist, Agricultural Engineering Research Division, Agricultural Research Service*

A moisture meter is valuable to the cotton ginner if it is properly used and its limitations are understood. It is useful both on the gin yard and in the gin. On the yard, it can be used to determine the approximate average moisture content of the seed cotton on trailers waiting for ginning. If grouping is practiced, it can be used for grouping

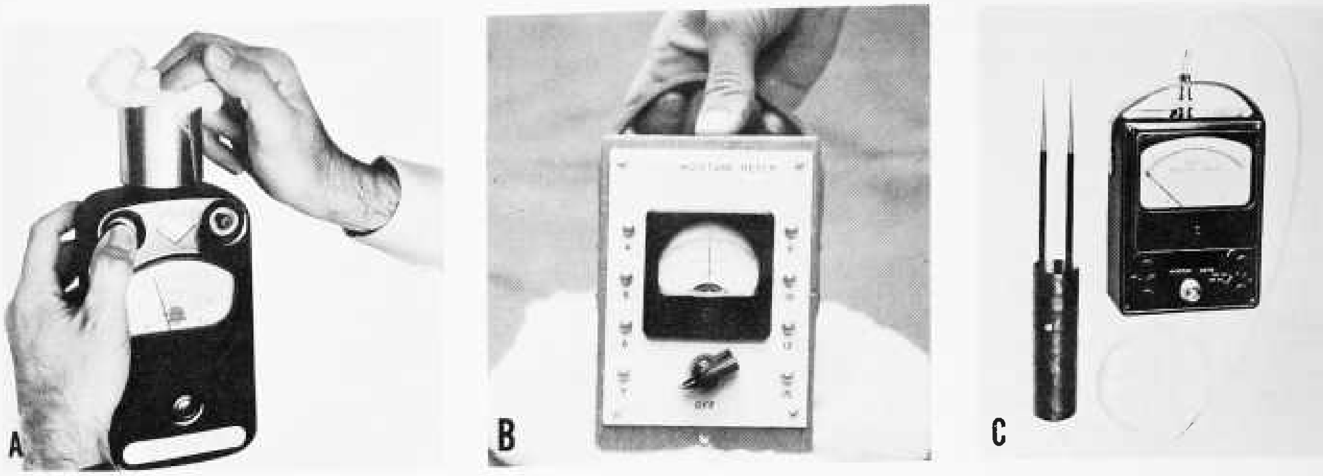


Figure 116.—**Representative commercial battery operated portable-type electric resistance cotton moisture meters: *A*, a meter being used with a sample cup in place; *B*, a meter utilizing direct contact electrodes; and *C*, a meter equipped with a multiple use probe.**

loads of seed cotton having similar moisture content. Some ginners mark the moisture percentage on the back of each trailer ticket, and some mark it on the trailer with chalk. When taking moisture readings of loads of seed cotton, two or more readings should be taken at different locations within the load. These readings should be averaged, because wide differences in moisture within the same load are not unusual. Readings should be taken at least several inches below the surface, because the outer portions of the load change rapidly with changes in the ambient air relative humidity.

Within the gin, seed cotton moisture measurements at the feeder aprons and lint measurements at the lint slide are the most common. Here, also, at least two samples should be measured and the results averaged. The size of the sample for testing should be no smaller than that recommended by the instrument manufacturer. In most electrical resistance-type moisture meters, the chance of error is greater when the sample is smaller than the recommended minimum size than when it is larger than the recommended maximum size.

Electrical moisture meters suitable for use at gins are of two types—the electrical resistance type (sometimes called the conductance type), and the capacitance type (also called the dielectric type). The electrical resistance type operates on the principle that the resistance of a mass of cotton to the flow of an electric current increases as the cotton becomes drier. The capacitance type operates on the principle that the capacitance of an electrical condenser varies with the moisture content of a mass of cotton placed between the condenser plates.

The methods of taking moisture measurements by means of electrical type meters are known as "secondary" measurement methods, and the meters must originally be calibrated by using a "primary" method such as the oven method (sometimes called the gravimetric method). The electrical resistance type has been widely accepted in the ginning industry, and a number of makes and models are commercially available. The resistance type has an advantage because it responds more rapidly to variations in moisture conditions than does the capacitance type (see figures 116 and 117).

The capacitance-type meters currently available are generally more bulky than the electrical resistance-type meters and require that the sample be weighed for accurate readings. Although for greatest accuracy the samples used in resistance-type meters should be weighed, this is generally not necessary and is seldom done.

Manufacturers of resistance-type meters suitable for gin use offer either multiple use probe or sample chambers, or a number of accessory sample electrodes that make the instrument useful for moisture measurement of seed cotton, cottonseed, and lint.

The use of a moisture meter by the ginner brings the importance of moisture to the attention of the producer-customer and should assure better bale values.

Moisture meters should be given reasonable care. Although they are generally ruggedly constructed, the meter movement and internal components can be damaged by severe mechanical shocks. Meters with bakelite cases should be protected from cracking or breaking.

Battery maintenance is important with battery operated instruments. Most difficulties encountered with this type of instrument are due to battery troubles. Corrosion is serious and may result from battery leakage. Failure to remove

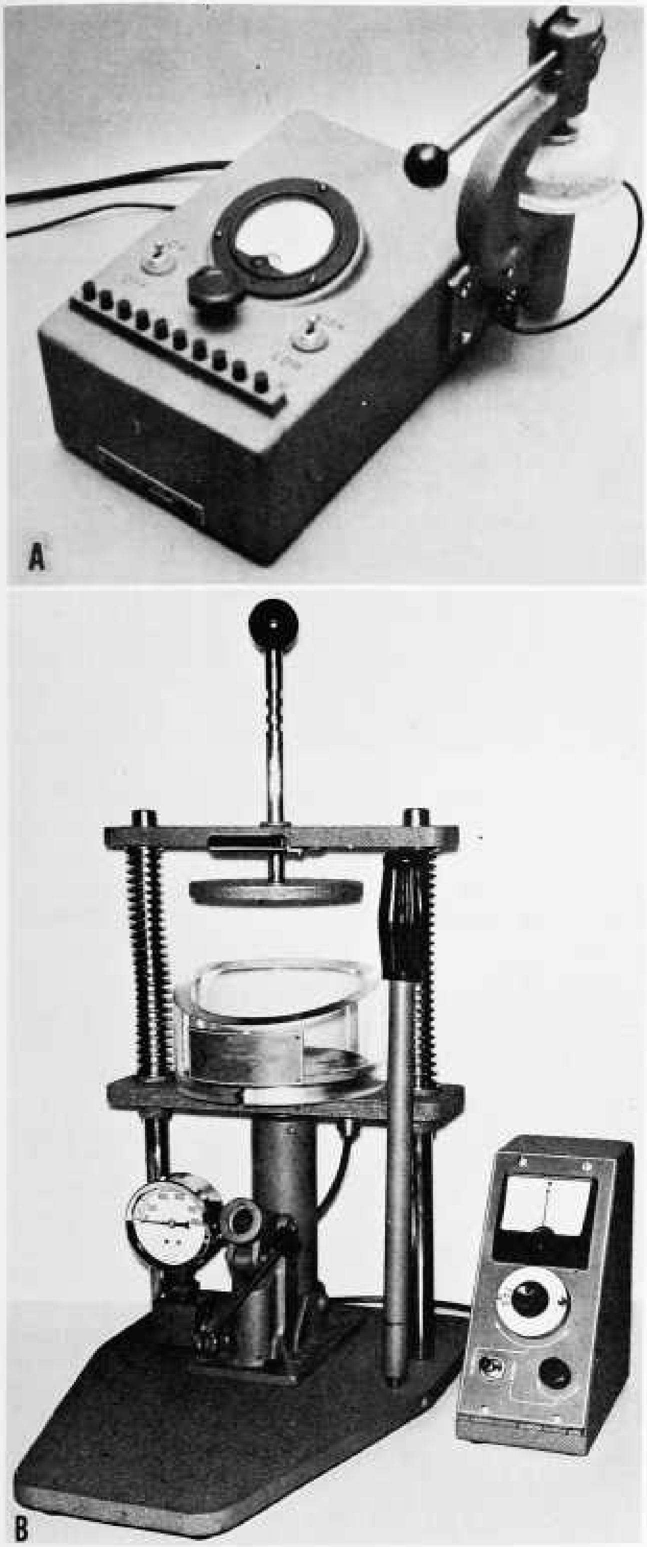


Figure 117.—Typical commercial line power-operated electrical resistance cotton moisture meters: *A*, an instrument with integral test chamber and indicator; and *B*, an instrument with separate sample test chamber and indicator.

batteries when the meter will not be used for prolonged periods usually results in battery wall failure, which permits liquids to escape and attack the internal components of the meter. At the close of the ginning season, batteries should be removed and discarded because they usually will not be suitable for further use. Table 24 lists several makes and models of moisture meters and gives their power requirements. When changing batteries, polarity must be observed.

The temperature of the sample affects the reading of a resistance-type meter. For accurate readings, temperature corrections should be made according to the manufacturer's recommendations. The electrical resistance of a mass of cotton de-

Figure 118.—A photograph showing the ragged appearance of cotton bales after sampling once or twice by the knife-cutting method.

TABLE 24.—*Power requirements of electrical resistance-type moisture meters used at cotton gins*

Moisture meter	Power requirements				
	A.C. line operated—50–60 cycle	Battery operated—battery size and type			
		1½ volts	22½ volts	45 volts	67½ volts
Hart K-101 [1]	No	Size D	None	Burgess Z30NX, Eveready W350, Ray-O-Vac 711, and RCA ZS114.	None.
Hart K-103	115 volts	None	do	None	Do.
Hart CU-2 [1]	No	Size D	do	Burgess Z30NX, Eveready W350, Ray-O-Vac 711, and RCA ZS114.	Do.
Hart R-41 [1]	do	Size C or D	do	Burgess XX 30, Eveready 455, and RCA VS055.	Do.
KPM Aqua Boy [1]	do	None	Burgess U-15, Eveready 412, and RCA VS084.	None	Do.
Murray Fiber-Rite.[1]	do	Penlight and Size C.	None	do	Burgess UX45, Eveready 416, and RCA VS318.
U.S. Testing Co., ACCO.	115 volts	None	do	do	None.

[1] Portable type.

creases as the temperature of the cotton increases. Therefore, the moisture content of the sample will appear higher if the reading is taken while the cotton is hot. This is generally not serious if the sample temperatures are within the range of 60° to 80° F.

Static electricity can cause reading errors and erratic deviations in the meter needle. This generally occurs only in dry weather, and particularly in dry, cold weather. Static charges on the meter can be removed by wiping with a damp cloth. Sometimes electrical grounding of an instrument will improve its operation when static charges are present.

Some suggestions for using moisture meters are:

(1) Be sure the batteries are good.

(2) Keep electrodes and insulation clean and free of moisture.

(3) Maintain proper sample size.

(4) Maintain sample density according to manufacturer's recommendations.

(5) Use an average of several samples for greater accuracy.

(6) Correct for atmospheric or cotton temperature to obtain greatest accuracy.

(7) Remove the batteries during long periods of storage.

(8) Remember that your moisture meter is an aid and not a cure-all for moisture control during ginning.

SAMPLING

By C. S. SHAW, *cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

Cutting cotton bales to secure samples is a long-established practice in the United States. However, because of changes in practices and facilities for ginning and marketing, this hand-sampling method may eventually be replaced by automatic sampling (*13*). Competition from synthetic fibers has also contributed to dissatisfaction with the hand method of sampling cotton. Synthetic textile fibers are generally handled in neat, uncut packages. Moreover, mutilated bales of cotton resulting from hand sampling have caused serious criticism of American cotton in world markets. Each bale of cotton may be sampled several times in marketing channels, some as many as five or six times (figs. 118 and 119).

Studies of automatic sampling of cotton at gins were started by the U.S. Department of Agriculture in 1938 (*7*) to: (1) Provide samples representative of the cotton throughout the bale; (2) reduce possibilities for human error in obtaining and identifying samples; (3) obtain samples uniform in size and appearance and favorable for accurate classification; (4) identify samples with their corresponding bales; and (5) sample without disturbing the bale coverings (fig. 120).

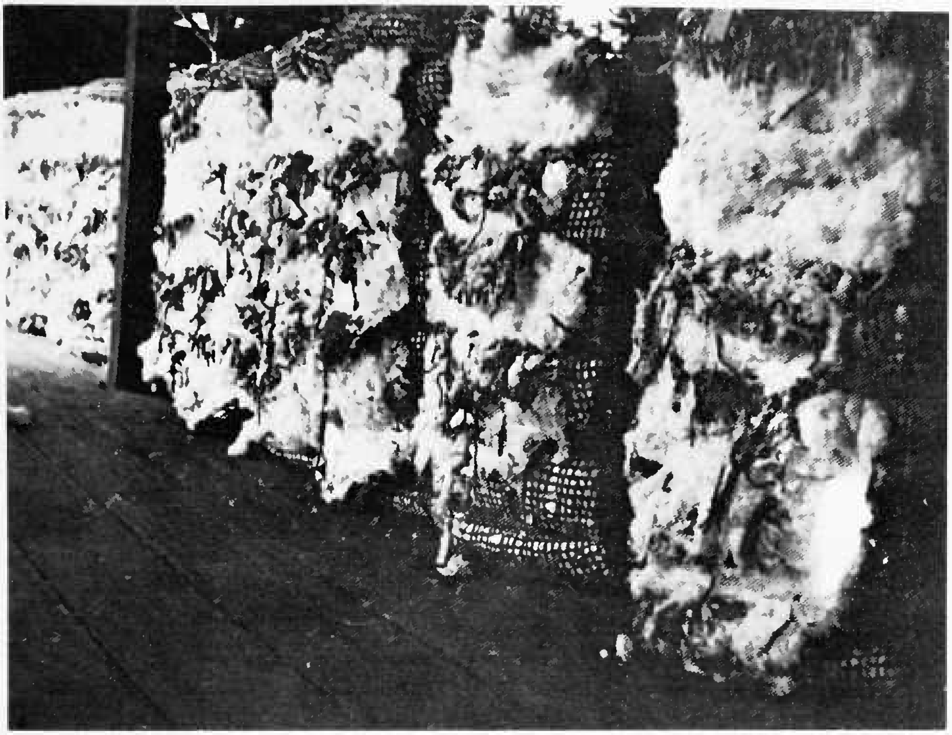


Figure 119.—A typical scene in an American cotton warehouse. These bales have been sampled four or five times by the conventional, knife-cutting method.

Figure 120.—Gin low-density and standard-density bales that were sampled progressively by an automatic sampler while the cotton was being ginned.

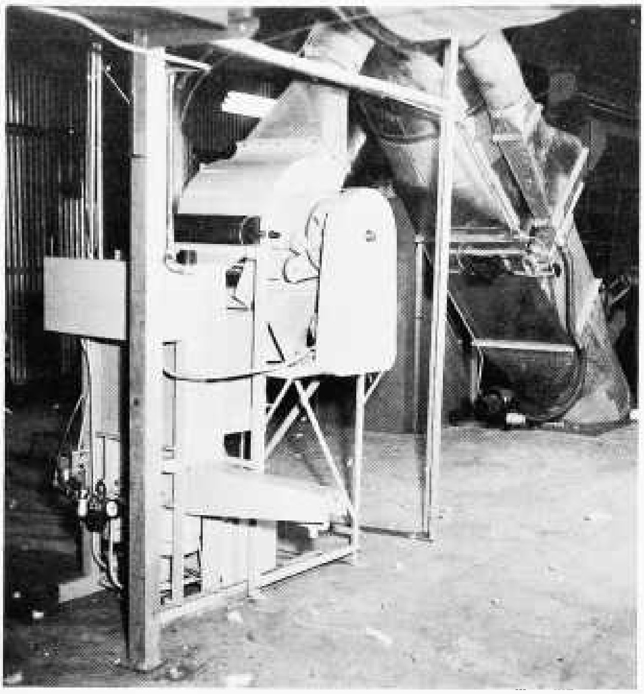


Figure 121.—**An installation of the USDA-developed automatic sampler and packaging unit in a commercial gin for testing purposes, 1952 ginning season.**

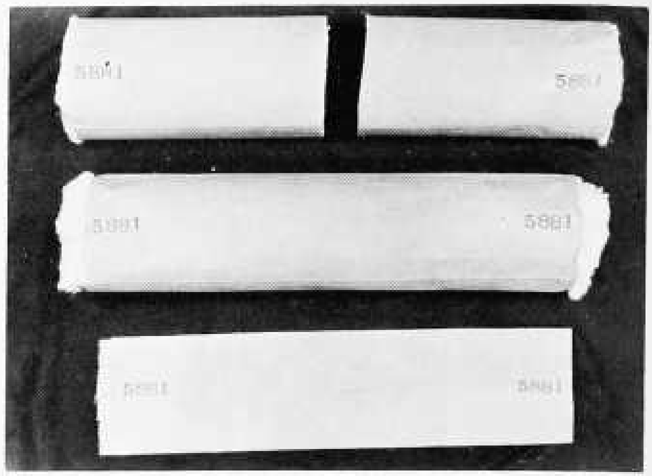


Figure 122.—**Sample produced by automatic sampler. Top shows sample cut in two; lower shows empty sample wrapper.**

Experiments with many principles and devices led to the development of a pneumatic type of automatic sampling device and automatic sample packaging unit of the type illustrated in figure 121. Samples produced are shown in figure 122. The recent interest of the entire industry in automatic sampling of cotton at gins has encouraged manufacturers to enter this field. As of 1963, two firms were engaged in the manufacture and sale of commercial equipment. This equipment has been confined mainly to the West and the Southwest. The salient features and the operation of the commercial equipment are based largely on the principles employed in the original USDA-developed sampler. The manufacturers have, however, made some important improvements in the form of simplifications for trouble-free operation.

Power: Motors and Engines

By W. E. Garner, *agricultural engineer, Agricultural Engineering Research Division, Agricultural Research Service*

The principal characteristics desired in cotton gin power units are constant speed, ample capacity to handle overloads, durability, and economy in operation and maintenance. The most common sources of power are electric motors and diesel, natural gas, and butane engines. Each has significant advantages and disadvantages.

A 1957 survey of gin equipment in the United States by the USDA Agricultural Marketing Service (*15*) showed that the percentages of each source of power for the main engine or motor were as follows:

	Percent
Electricity	56.5
Diesel fuel	23.0
Natural gas	10.4
Butane	7.9
Gasoline	1.7
Other	0.5

Several factors should be considered in selecting a power unit for a given installation. Among these are amount of power required, initial cost of equipment, cost of fuel or electric energy, cost of lubrication, kind of labor needed, expense of maintenance, probable length of life, and decrease in power capacity resulting from use.

Diesel, natural gas, and LPG engines have much to commend them for the seasonal service of cotton ginning. In selecting such engines, the purchaser should allow for a liberal margin in power over that which is actually required. This allowance should be for future expansion. Also, manufacturers may list their engine ratings at the maximum power produced when the engines are new. Capacity will decrease with service.

Table 25 lists the brake horsepower and other characteristics of several engines designed for continuous cotton gin service.

Figure 123 shows a diesel engine installed in a cotton gin as the main source of power.

The amount of electrical energy required varies considerably, depending on how constant and intermittent loads are handled and on how much fans and other accessories are used. In electrically operated gins, it is highly advisable to have separate motors carry the various loads of intermittent work of pumps, presses, and seed loading rather than have the main motor carry these loads. In many large gins, this has resulted in numerous motors for individual drives. Electric power companies usually offer consulting and testing services to their patrons.

Manufacturers of cotton ginning machinery publish data sheets that give the recommended horsepower for their various machines, such as gin stands, separators, cleaners, and condensers, operating at varying capacities. These data sheets usually show the recommended size of an indi-

Table 25.—*Brake horsepower, engine speeds, and other characteristics of several engines designed for continuous cotton gin service* [1]

Model and bore and stroke	Cylinders	Displacement	Brake horsepower at engine speeds of—							
			600 r.p.m.	800 r.p.m.	1,000 r.p.m.	1,200 r.p.m.	1,400 r.p.m.	1,600 r.p.m.	1,800 r.p.m.	2,000 r.p.m.
	Number	*Cubic inches*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*	*Hp.*
H570, 4⅝ x 4¼	8	570		54	71	87	103	118	134	149
H884, 5⅜ x 4⅞	8	884		90	114	138	161	184	204	223
F1500, 6¾ x 7	6	1,503	107	141	171	184				
H2000, 6¾ x 7	8	2,004	144	192	224	240				
L3000, 6¾ x 7	12	3,006	220	280	348	368				
L3460, 7¼ x 7	12	3,468	254	339	424	495				
L4000, 7.54 x 7.5	12	4,000	308	400	492	565				

[1] Ratings are for continuous gin service on LPG fuel, and are 80 percent of maximum ratings. For 1,000 B.t.u. of natural gas fuel, deduct 10 percent.

Source: Waukesha Motor Co.

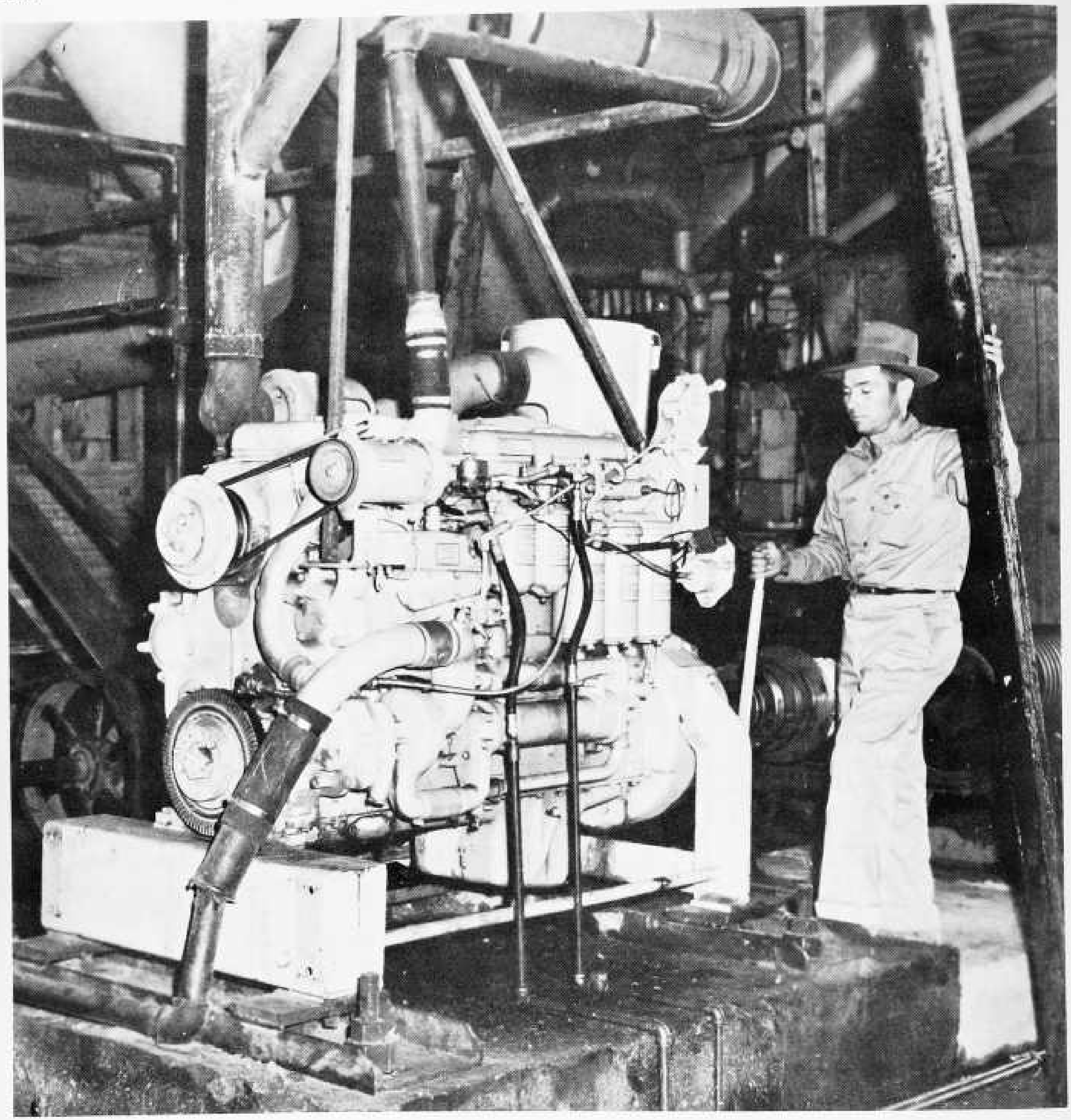


***Figure 123.*—A diesel engine installed in a cotton gin. This engine is the main source of power for the gin.**

vidual electric motor and the horsepower for calculating total horsepower requirements for a central engine-driven plant. The horsepower for purposes of calculation in a central engine-driven plant is less than the recommended horsepower for individual electric motors. This is due to the fact that normally an individual machine will require much less horsepower than is required to overcome periodic surges of flow through the equipment. In a central, engine-driven plant, the surges will average out at any one time; so that the overall load on the central engine will never need to be as great as the sum of the horsepowers of the electric motors when the machines are individually driven.

Electric motors for powering cotton gins must be able to operate in air heavily laden with dirt and lint, which is common to cotton gins. Also, the ambient temperatures, particularly in the upper areas of a cotton gin, often become very high. In addition, it is impossible to obtain uniform power requirements for the various machines in the gin plant, even though bulk feed-control units have done much to level out the extreme surges in power requirements. Uniformity in these conditions is difficult for any one type of electric motor to attain.

The totally enclosed motor will prevent dust and lint from getting into the motor, but even the fan-cooled variety of this motor does not have the overload carrying capacity of the open motor, which can dissipate heat more easily. The totally enclosed motor may give more trouble because of overheating than the open motor will give because of contamination from dust and lint. A compromise may be a motor built in a large frame that has large openings to prevent clogging by lint and dust. The large frame enables this motor to dissipate heat more readily. Thus, the motor can operate under overloads of more than 25 percent for short periods of time to overcome the incalculable surges that sometimes develop in gin machinery. The cost of this large-frame, open motor is between the cost of a standard drip-proof motor and the cost of the totally enclosed fan-cooled motor, which is the most expensive. Despite its apparent shortcomings, many standard drip-proof motors are giving satisfactory service.

Gins to Handle Specific Types of Cotton

By V. P. Moore, *cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

Numerous tests by the four Cotton Ginning Research Laboratories and cooperating agencies of the USDA have led to recommendations on the amount of gin machinery to be used with cotton harvested by various methods that will give satisfactory bale value for the producer on one hand and that will preserve the inherent quality of the cotton on the other.

Research has shown that cotton varieties produced in the raingrown areas of the Cotton Belt, for all practical purposes, have about the same cleaning characteristics.

HAND-PICKED COTTON

Tests at Clemson, S.C., showed that little cleaning is necessary on the relatively clean early season, hand-picked cottons. A master feed-control unit to meter the seed cotton into the system, a full tower drier or the equivalent, 7 to 14 cylinders of seed cotton cleaning, a bur or stick-and-green-leaf machine, and large extractor feeders, are all the machinery necessary to produce satisfactory grades from clean, hand-picked cottons, which are rapidly disappearing (fig. 124). During the middle and latter part of the season, one lint cleaner in addition to the machinery listed was found desirable.

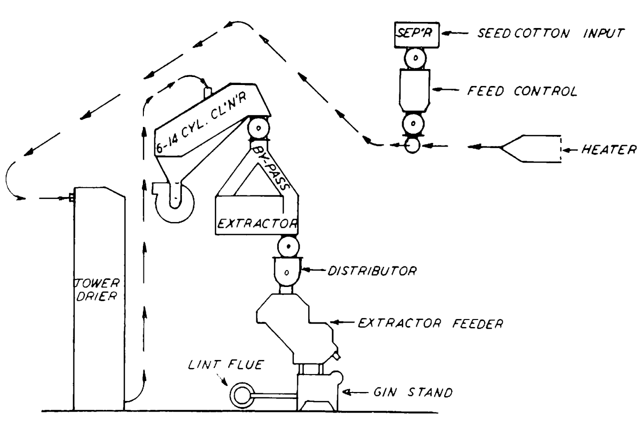


***Figure 124.*—Ginning machinery setup recommended for use with clean, hand-picked cotton.**

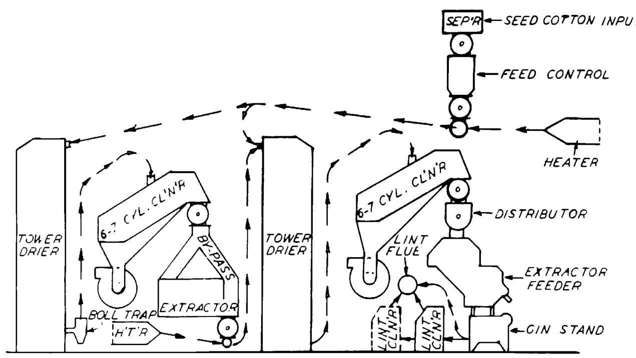


***Figure 125.*—Ginning machinery setup recommended for use on machine-picked cotton.**

MACHINE-PICKED COTTON

For machine-picked cotton, a much more elaborate gin is necessary to obtain grades acceptable to the mills and to yield good returns for the producer. The Midsouth has more moisture generally than does the Southeast; therefore, more drying of the hand-picked cottons is needed. Because of moisture that is added on the picker spindles, more drying is generally needed on the machine-picked than on the hand-picked cottons in both areas. A gin to handle these roughly harvested cottons is shown in figure 125. It consists of a feed control, 2 full-sized tower driers or the equivalent, a boll trap, 12 to 14 cylinders of seed cotton cleaning, a bur machine or stick-and-green-leaf machine, large extractor feeders, and 2 lint cleaners. Preliminary tests do not indicate that the smooth-leaf cottons that are coming into widespread use will materially change these recommendations.

Cotton varieties produced in irrigated areas have had better cleaning characteristics than have raingrown varieties. Studies at the Southwestern Cotton Ginning Research Laboratory, Mesilla Park, N. Mex., showed that the same amount of seed cotton cleaning machinery shown in figure 125 (with just one lint cleaner) will usually produce lint of satisfactory quality from the machine-picked cottons.

MACHINE-STRIPPED AND HAND-SNAPPED COTTON

Tests at the laboratories at Mesilla Park, N. Mex., and Chickasha, Okla., showed that considerable extracting equipment is necessary to obtain satisfactory grades for machine-stripped cottons. Also, an air-line cleaner in the wagon suction line is advisable. The cleaner will be more efficient as a boll breaker if the first cylinder is speeded up 15 to 25 percent above the remaining cylinders. Machinery recommendations for handling these hand-snapped and machine-stripped cottons in Oklahoma and the High Plains include a feed control, green boll trap, 4- or 5-cylinder air-line cleaner, tower drier or equivalent, 6- or 7-cylinder cleaner, bur machine with stick-and-green-leaf machine, tower drier or equivalent, 6- or 7-cylinder cleaner, bur machine with stick-and-green-leaf machine, tower drier or equivalent, 6- or 7-cylinder cleaner, large extractor feeders, and 2 lint cleaners (fig. 126). These recommendations are about the maximum. The more cotton is handled, the less is its potential use value. Therefore, adequate by-passes should be provided and a minimum of machinery used to obtain satisfactory grades.

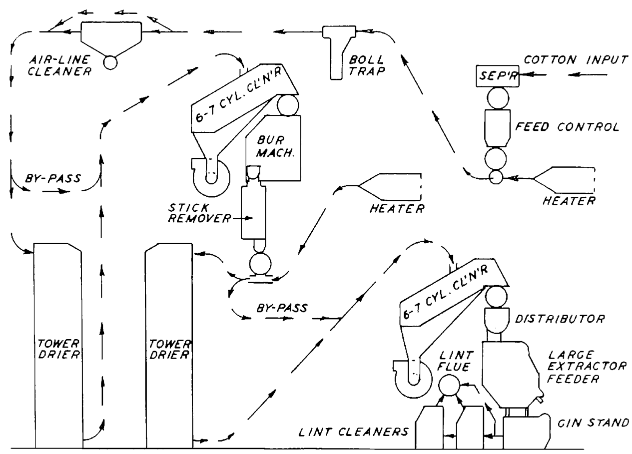


Figure 126.—**Ginning machinery setup recommended for use on machine-stripped and hand-snapped cotton.**

Recommended Ginning Practices

By V. P. Moore, *cotton technologist, Agricultural Engineering Research Division, Agricultural Research Service*

If not operated properly, the complex modern gin can damage the potential spinning quality of cotton in a number of ways. Tests made at the ginning research laboratories have shown that the various processes can in some way affect all the known measurable fiber properties with the exception of fineness and maturity.

The elements of quality that may be affected by these various ginning processes may be summarized as follows:

Gin Process:	*Quality element affected*
Overdrying	Staple length Tensile strength Length uniformity Yarn strength
Underdrying	Grade Preparation Length uniformity Yarn appearance Manufacturing waste
Cleaning and extracting	Grade Neps Yarn appearance Manufacturing waste
Gin stand operation and lint cleaning	Grade Staple length Preparation Length uniformity Neps Yarn appearance Manufacturing waste

To avoid quality damage, a guide has been developed in cooperation with the Extension Service and industry groups. This guide to quality ginning, known as the "Four-Point Ginning Program," is as follows:

(1) Use only enough drying for smooth ginning and proper cleaning.
- (a) Five percent to 7 percent lint moisture is best for quality preservation.
- (b) Use moisture meter on lint slide samples to adjust drying.
- (c) Adjust burners to provide desired temperature with minimum flame fluctuation.

(2) Use only necessary seed cotton and lint cleaning equipment.
- (a) Clean cotton requires minimum treatment.
- (b) More cleaning is needed for machine-picked cotton.
- (c) Additional extracting is needed for snapped and machine-stripped cotton.
- (d) Bypasses are necessary to attain proper machine selection.

(3) Maintain uniform flow of seed cotton through the ginning system.
- (a) To improve drying.
- (b) To improve cleaning.
- (c) To reduce overflow.
- (d) To increase capacity.
- (e) To reduce chokage.

(4) Operate gin stand at no more than recommended capacity.
- (a) For smooth preparation.
- (b) For better cleaning.
- (c) For less fiber damage.
- (d) For fewer neps.
- (e) For better spinning performance.

Miscellaneous

DUTIES OF A GIN CREW

By V. P. Moore and G. N. Franks, *cotton technologist and agricultural engineer, respectively, Agricultural Engineering Research Division, Agricultural Research Service*

Ginning has become big business. As every ginner knows, it represents a large investment and must be operated at a high degree of efficiency if the investment is to be profitable.

The full advantage of a modern, high-efficiency plant will be lost by a crew that wastes just 1 minute between bales. Ginning 1 bale every 6 minutes in a plant capable of turning out 1 every 5 minutes means an efficiency loss of about 20 percent. In terms of gross revenue, this will amount to some $400 per shift.

The gin is no more efficient than are the people operating it. Too often, the underlying reason for reduced efficiency and the corresponding loss in revenue can be attributed to poor crew training, which results in poor operation and maintenance.

More and more gin owners are finding that it is to their advantage to retain the key members of the gin crew on a year-round basis. Trying to pick up a crew at the start of the season is poor economy.

Gin owners are also finding that it is a good investment to make it possible for gin managers, gin superintendents, gin stand operators, and lint cleaner operators to visit the gin machinery manufacturers; to attend gin schools and cotton classing short courses; and, in general, to take advantage of every opportunity to learn more about operating and maintaining the plant. It is unfortunate that facilities for training gin personnel are extremely limited. However, the industry is becoming increasingly aware of a real need for a trade-school type of training facility for gin personnel.

Each gin crew has somewhat different operational characteristics (*9*). The size of the operation and the temperament and capabilities of the individuals all influence the makeup of the gin crew. However, the crew of a 4- to 5-stand gin having a capacity of 10 or more bales per hour should have a plant manager, a gin superintendent, and a gin stand operator for each shift; a lint cleaner operator; a press operator and two helpers; a sucker pipe operator; and one or two yard men who alternate as sucker pipe operators. The qualifications and duties of these individuals include the following:

Manager

QUALIFICATIONS:

Detailed knowledge of office procedures; detailed knowledge of gin maintenance and operation, including the function of each machine; and ability to recognize when machines are operating at top efficiency. General knowledge of cotton and what to look for in a sample to check on quality preservation from the standpoint of the cotton classer.

DUTIES:

- Employs personnel
- Trains personnel
- Assigns duties
- Has direct supervision of gin superintendent and bookkeeper
- Checks moisture content of each trailer of cotton
- Periodically checks entire gin plant operation
- Assists gin superintendent as needed
- Makes decisions as to repairs and whether gin should be shut down immediately or wait for shift change
- Is responsible for gin maintenance and for general and seasonal repairs
- Deals with the public
- Supervises activities on the yard, such as grouping of cotton and handling of trailers

Gin Superintendent

QUALIFICATIONS:

Working knowledge of gin machinery, electrical equipment, burners, and safety devices, and their operation and maintenance; knowledge of seed cotton and lint moisture and their significance in ginning; knowledge of the possible effects of gin machinery on cotton quality and how to identify these effects from the cotton classers' standpoint.

DUTIES:

- Is directly responsible for minor gin maintenance and repair on his shift
- Has direct supervision of personnel
- Is directly responsible for smooth operation of gin plant

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Assists gin stand operator when not otherwise engaged
Supervises cleanup and housekeeping operations
Acts as fire chief in case of fire
Assigns people to make repairs
Acts as assistant manager on his shift

Gin Stand Operator

QUALIFICATIONS:
General knowledge of proper gin operation and maintenance.

DUTIES DURING OPERATION:
Devotes full time to gin stands
Watches for and immediately removes tags from ribs
Keeps stands operating at designed capacity
Adjusts feed control
Constantly checks for irregularities, slack belts, hot boxes, and loose pulleys
Watches for fires
Acts as assistant gin superintendent

DUTIES DURING LUBRICATION AND CLEANUP PERIOD:

When going off duty—

Checks gin stand, mote boards, mote conveyors, saws, ribs
Oils gin stand and feeder bearings as required
Checks belts and belt lacings (during the first 2 weeks of the season, all belts should be inspected every time machinery stops)
Checks feeder saws, brushes, and screens
Calls any irregularities to the attention of the superintendent

When coming on duty—

With the assistance of two pressmen checks, services, and cleans overhead machinery. This involves—
Opening all inspection doors on each machine
Checking screens, grids, extractor saws, trash conveyors, and augers. (Material left wrapped around augers can start fires.)
Lubricating and inspecting bearings
Checking belts and lacings
Cleaning top of house and machinery
Calling irregularities to the attention of superintendent

DUTIES DURING FIRE:

If fire is overhead—

Kicks out gin stands
Cuts off feeders and hopper boxes
Closes front of stands to spill cotton on floor
Cuts off feed control
Sees that machines are not stopped if overhead equipment is not choked up

If fire is in stand or lint cleaner—

Cuts off feed, clears stands of cotton
If seed roll is on fire, dumps it after seed conveyor has stopped

Lint Cleaner Operator

QUALIFICATIONS:
General working knowledge of lint cleaners.

DUTIES DURING OPERATION:
Keeps grid bars clean
Checks trash conveying system
Checks for irregularities in the flow of cotton
Assists gin stand operator as needed
Keeps machines and floor clean

DUTIES DURING LUBRICATION AND CLEANUP PERIOD (assisted by operator coming on duty):
Opens all inspection doors
Checks condensers
Checks brushes
Checks lint flues for tags
Cleans machines and floor around them
Calls irregularities to the attention of superintendent

DUTIES DURING FIRE:
Assists gin stand operator
Checks lint cleaners for smoldering trash and removes cotton or wraps around shafts before starting up

Press Crew

DUTIES DURING OPERATION:

Press Operator—

Supervises and operates the press
Assists in tying out bales and dressing press
Constantly checks on lint slide and tramper
When not tying out a bale, stands or sits where he can observe machinery

Press Assistants—

Keep press supplies available
Put buckle on bands
Lay out bands
Assist in tying out bales
Tag and truck cotton to scales and platform
Draw samples if required
Perform general housekeeping

DUTIES DURING LUBRICATION AND CLEANUP PERIOD:

Press Operator—

Checks and lubricates tramper and condenser
Checks belts and drives
Cleans condenser flue
Checks exhaust fans

Press Assistants—

Report to ginner to assist in inspecting, lubricating, and cleaning overhead machinery

DUTIES DURING FIRE:

Press Assistants—

If no fire reaches the pressbox, report to superintendent immediately

Assist in cleanup after fire—carry smoldering cotton outside as quickly as possible; leave tramper in the down position to contain the fire while it is being brought under control

Sucker Pipe Operator

DUTIES DURING OPERATION:

Feeds at as uniform a rate as possible

Digs into each load to check for uniformity of moisture

Checks for large variations in trash or moisture while feeding; if large variations are noted, immediately stops feeding and notifies superintendent. This helps avoid chokages.

DUTIES DURING LUBRICATION AND CLEANUP PERIOD:

Assists lint cleaner operator and cleans floors

DUTIES DURING FIRES:

Stops feeding

Immediately lays out fire hose in front of gin stand

Assists in cleanup when fire is out

Yard Man

DUTIES DURING OPERATION:

Supervises parking of trailers in orderly manner on yard

Keeps trailers supplied to sucker pipes

Moves empty trailers away from gin

Assists manager in making moisture tests

Alternates with sucker operator in feeding gin

DUTIES DURING LUBRICATION AND CLEANUP PERIOD:

Assists gin operator

DUTIES DURING FIRE:

Reports inside and, unless instructed to do otherwise, immediately lays out hose behind gin stands so that it may be immediately available if needed.

The men selected for a gin crew should be able to read and write. Also, they should have a good safety record.

The shifts should overlap some 10 to 15 minutes, and the crews should work together in cleaning, inspecting, and lubricating. This minimizes downtime. With a little supervision and some housekeeping while the plant is running, 10 minutes will be ample.

The manager should make a special effort to train people for the more responsible jobs. A training program will assure a smoother running operation with a minimum of interruption because of sickness or changing personnel.

The gin should be equipped with some type of fire alarm for fire control. Insurance requirements should be met, but, in addition, there should be one hose in front of the gin stands and one behind. Preferably, these hoses should be equipped with fog nozzles. They should be laid down each time the fire alarm sounds. Water should be used sparingly; it takes a long time to clean up a wet gin. Furthermore, wet belts slip and run off pulleys; this causes chokages and more downtime.

Every member of the gin crew should have a definite assignment and station to report to when the fire alarm sounds.

In the modern gin plant, selecting reliable men and training them is an excellent investment.

FIRE INSURANCE CONSIDERATIONS

By A. SIDNEY BRIGGS, *manager, Fire Prevention and Engineering Bureau of Texas*

Fire prevention and fire protection are important in maintaining the position of cotton in the fiber market. Fire insurance premiums on cotton gins and cotton products reflect the fire losses suffered by the industry. It is, therefore, important to keep the insurance costs to ginners and cotton manufacturers at a minimum by preventing fires.

Fire insurance inspection and rating bureaus located throughout the cotton-growing areas should be consulted on matters pertaining to arrangement or layout, construction, hazard control, and protection. These bureaus have available the standards announced by the National Board of Fire Underwriters. Standards prescribed for cotton gins are fundamentally the same in all cotton-growing areas, but they vary in detail. The rating bureaus are familiar with these standards and have available for free distribution pamphlets on standards and on fire protection devices and materials listed by Underwriters' Laboratories, Inc. The devices used and the materials procured should meet the necessary tests and be approved by the rating bureau.

Detailed information on the following items may be secured through the bureau having jurisdiction in your State. Asterisks indicate that special standards are available in the bureau office.

Arrangement or Layout

Auxiliary buildings.—These buildings should have a minimum of 40 feet clear space from the gin building.*

Open cotton storage yards.—These yards should be located at least 200 feet from the gin yards or structures.*

Entire gin plant.—The entire plant should be separated from outside exposures (structures not a part of the gin plant, and highways) as far as is economically feasible.*

Construction

Buildings.—Buildings should be constructed of fire-resistant and noncombustible material, securely erected. Buildings so erected have a materially lower fire insurance rate and maintenance cost. Floors, platforms, and decks, as well as auxiliary buildings and structures, should also be constructed of noncombustible materials.*

Machinery.—All metal machinery, installed in accordance with manufacturer's specifications and arranged so as to be readily accessible and free from congestion, should be used throughout.

Power, Lighting, and Heating Facilities

Electric wiring and equipment.—Electric wiring and equipment should be installed in accordance with National Electric Code.*

Electric motors.—Unless separated from ginning section to avoid dust and lint, electric motors of the type approved for Class III (National Electric Code) should be used.*

Internal combustion engines.—Internal combustion engines should be in a separate room, free from dust and lint. If liquid fuel is used, it must be supplied by pump and not by gravity. Exhaust should discharge to outside of building with a minimum clearance from combustible material of 9 inches.*

Fuel tanks and piping.—Fuel tanks and piping should be installed in accordance with National Board of Fire Underwriters' Pamphlet No. 30, "Storage, Handling and Use of Flammable Liquids." If liquefied petroleum gas is used, comply with National Board of Fire Underwriters' Pamphlet No. 58, "Storage and Handling of Liquefied Petroleum Gases," and Pamphlet No. 54, "Gas Appliances and Piping."*

Heaters.—Open flame heaters should not be used. Bureaus have detailed standards for different types.*

Hydraulic press fluids.—Only those hydraulic press fluids that have the proper quality and a sufficiently high flash point should be used. (U.S. Bureau of Mines has recommended certain fluids to avoid explosions and fires.)

Special Hazards

Trash disposal.—Gin trash (burs, sticks, etc.) should be collected in adequate, noncombustible hoppers, equipped with cyclone or other type separators. The trash should be removed as it accumulates. To avoid a sizable charge for improper handling, consult the bureau for details of arrangement.

Heating units for cotton driers.—Heating units for cotton driers should be installed in a separate room, free from dust and lint, in accordance with manufacturers' specifications. Proper heat and fuel controls are necessary for fire prevention and quality control.

Protection

Fire protection for cotton gins varies with the types of construction, the availability of water, and the economic factors involved in each case. Standards for outside and inside protection and the credits applicable for their observance are important data and are available at the bureau.

Outside protection (public or private).—Standards for outside protection, including the amount of water available, the size of the mains, the number of hydrants, and the most practical layout arrangements, are described in detail by the bureau.*

Inside protection.—For inside protection, casks, pails, and approved types of portable and wheeled extinguishers should be installed in required numbers (usually based either on area of building or on number of gin stands) and should be maintained as prescribed.* Extinguishers are "approved" for the class of fires they are expected to combat, as follows: Class A—Ordinary combustible fire; Class B—oil fire; and Class C—electrical fire.

Automatic sprinkler systems.—One important prerequisite for an automatic sprinkler system is an adequate water supply. Plans prepared by a qualified installer for specific systems should be submitted to the bureau for approval. The bureau also checks completed installations.*

Fixed-type carbon-dioxide systems.—Fixed-type carbon-dioxide systems should be installed in accordance with prevailing standards. Plans prepared by a qualified installer should be submitted to the bureau for approval. The bureau also checks completed installations.*

Inside standpipe and hose.—Where sufficient water is available, inside standpipes and hose may supplement other protective devices. The bureau will also furnish recommendations.*

Magnetic separators.—Magnets used shall be those listed by Underwriters' Laboratories, to assure proper strength. Locate as prescribed by the bureau.*

Administrative Precautions

For maximum efficiency of production and minimum fire hazard, premises should be kept clean and free of weeds and grass.

Machinery and equipment should be installed as prescribed by the manufacturer and by the insurance inspection and rating bureau, and should be kept in good working order.

All employees should be trained in proper use of all fire-protection equipment. In case of fire, first the alarm should be given, and then the rules learned in practice should be applied.

Congestion on yards by trailers and cotton products should be avoided. To avoid panic and spread of fire, easy exit for vehicles should be provided.

If baled cotton is stored overnight, a minimum of 40 feet of clear space from the gin building should be provided.

"No Smoking" and "Restricted Smoking" signs should be posted in designated areas.

Every precaution should be taken to avoid fire-packed bales. When a bale is "suspect," all concerned should be notified.

Adequate insurance, placed in sound companies, should be provided for complete protection.

GIN SAFETY

By Tony Price, *public relations director, Texas Cotton Ginners' Association*

The high frequency of injuries to cotton gin employees can be traced directly to unsafe practices by the workers and unsafe conditions existing in the ginning facilities. Enforcement of safe practices and standards by the management through an organized program of accident prevention will reduce the causes of accidents. Because of the many variations in ginning installations, only minimum standards are discussed here. Safety practices and procedures should be adapted to fit individual gin operations. Repeated emphasis on safety through direct contact with workers is of major importance in preventing gin accidents. Weekly meetings with employees to study safe practices and safe conditions are desirable.

Safe Practices

The following practices should be observed by employees in all cotton gins:

(1) Employees should wear comfortable, close-fitting clothes. Sleeves should not be rolled and should fit snugly at the wrists. Gloves should never be worn in the gin.

(2) Employees should have scratches, cuts, and other injuries treated immediately, no matter how minor they appear to be.

(3) All work areas should be kept free of trash, debris, tools, and any objects that obstruct safe and normal passage. Tools should be returned to designated storage areas or racks as soon as they are no longer needed.

(4) Oil and grease slicks should be wiped up as they appear.

(5) Repairs and adjustments to machinery should be made only by skilled personnel.

(6) Each employee should make sure fellow employees are clear of machinery before power is turned on. All guards and covers should be replaced before machine is started.

(7) Belts should not be thrown on or off while machinery is running. Belts should be rolled onto pulleys and flywheels by hand. Extreme caution should be used.

(8) Gin breast should be raised before dumping the seed rolls. Seed should be raked out with a stick when rolls are dumped.

(9) High-compression air nozzles should be used to clean out knots, tags, and fly.

(10) Air nozzles should not be cleaned while the gin stand is running. Gin stands should not be operated with exposed saw cylinders.

(11) Fingers should not be put within 6 inches of saw cylinders in either stands or cleaners. When work on saws is necessary, the power should be shut off. Panels or guards should be removed only after the saw shafts have stopped turning.

(12) Lint gate should not be opened while the press is in operation. Press door should not be opened until the ram stops. Tramper foot should not be cleaned while it is in motion, and tramper belt should not be guided by using stick or rod while it is in motion.

(13) Turning press should be carefully watched. Older presses should be pushed with hands, not with shoulders.

(14) Yardsmen and suction feeders should not jump out of trailers or trucks; they should use ladders to climb in and out of cotton trailers. They should not attempt to guide a trailer that is being pushed, and they should stand with their feet clear while handling trailer tongue. When a trailer is hooked up to a tractor or truck, the driver should always know what is happening.

(15) Motors should be shut off while refueling vehicles. Gasoline should not be used for any cleaning job.

Safe Conditions

The following conditions should be maintained at cotton gins for safety of employees and equipment:

(1) All machinery should be inspected frequently for worn parts and for worn or cracked belts and chains; for loose fittings and couplings; and for other hazards. Repairs and adjustments should be made immediately. Any existing hazard should be brought to employees' attention.

(2) A first-aid cabinet equipped at all times with supplies for emergency treatment should be located in a central place in the gin building.

(3) Line shafts and conveyors that cross normal walkways should be covered. Those at floor level should be covered with removable grids or plates.

(4) Firefighting apparatus should be located in clearly marked areas that have easy access. The pressure and level of extinguisher liquids should be checked frequently.

(5) All belt and chain transmissions should be guarded to a height of 7 feet above the working level.

(6) Air compressors should be behind barrier-type guards and should be treated as an operating piece of equipment at all times.

(7) All catwalks and walkways above the floor surface should have adequate guardrails. All stairs should have sturdily constructed handrails high enough to prevent an adult from falling from the guarded surface.

(8) Ladders (portable and stationary) should be inspected frequently for loosely connected rungs, cracked or split rungs, or side rails. All portable ladders, except certain stepladders, should have safety grip bases.

(9) An audible signal, horn, or bell should be connected to the master switch to sound a warning when machinery is being started.

(10) Grid-type guards should be provided for lint cleaners. Grids should be spaced to permit use of an air nozzle without removal of guard, but close enough to prevent a worker from extending his hand through the grids.

(11) With the addition of new machinery and pipes, ladders and stairs should be relocated if necessary to maintain easy access at the top and bottom of these structures.

(12) Hoists and chains should be examined frequently for excessive wear and hazardous condition.

(13) Sturdy ladders should be furnished at the suction for use by suction men to climb in and out of trailers and trucks.

Glossary

Absolute humidity: The weight of water vapor existing in the atmosphere. It is usually expressed either as grains per cubic foot or pounds per pound of dry air.

Air-blast gin: One that doffs the ginned lint from the saws by a blast of air.

Air-draft cleaner: Air-line cleaner made by Lummus Cotton Gin Co.

Air-line cleaner: One in which the cotton is conveyed while in the gin suction piping; i.e., in the "air line."

Air valve: The automatic or manual suction-breaker to stop flow of air at the cotton telescope, or to switch flows of air.

Automatic feed control: Apparatus for automatically controlling the volume of seed cotton flow to the ginning system.

Bollie: A cotton boll that is dry, but that has not opened because of weather, insect, or disease damage.

Boll separating device: A device on the stripper-type harvester to separate the immature and unopened bolls from the open, mature bolls.

Boot: The flexible canvas at the upper end or bell of the telescope. May also be made of metal.

Breast (or front): Front of a gin stand.

British thermal unit (B.t.u.): The quantity of heat required to raise the temperature of 1 pound of water 1° F.

Brush gin: One that doffs the ginned lint from the saws by a brush.

Buckle: A metal device for securing the ends of cotton ties placed around the bales of lint cotton.

Bypass: A passage around a machine to avoid use of the machine.

Cleaner: A machine for removing dirt and small trash from seed cotton. Does not do "extracting."

Cleaning feeder: A cleaner and feeder combined.

Condenser: A machine to collect ginned lint into a smooth, endless "batt."

Cotton ties: Strips of thin steel used to wrap around cotton bales, which, when used with buckles, form securing bands around the bale. The ties are secured on the bale before its release from the press.

Counterflow drier: The type of drier in which the hot air enters one end of the drier and the material to be dried enters the opposite end. The reverse of "parallel flow" or "concurrent."

Cyclone or collector: A device for separating materials from air streams.

Defoliation: Natural or artificially induced shedding of leaves from the cotton plant. Chemicals are normally used to "defoliate" cotton to aid mechanical harvesting.

Desiccation: Killing leaves on the cotton plant with a chemical. Leaves do not wilt and fall off plant as in defoliation.

"Dinky" press: Small bale press used at cotton compress establishments for squeezing the bale together to permit removal of ties.

Distributor: A device to distribute seed cotton to various machines or cotton gins. Excess cotton from this device is discharged at the overflow. A distributor may be of the belt type, pneumatic, or equipped with auger or helical screw.

Doffer rolls: Rolls that doff, or strip, the ginned lint from the condenser drum.

Doffing: The act or process of removing cotton lint from any part of a machine.

Drier: Apparatus for lowering the moisture content of seed cotton.

Extractor: A device for extracting burs, stems, whole leaf, and other trash from seed cotton. May do some cleaning also, but should not be confused with a cleaner.

Extractor unit: A small extractor suitable for use in replacing a cleaning feeder over a gin stand. (Usually made in gin stand widths.)

Feeder: *See* Cleaning feeder.

Feeder apron: The apronlike discharge pan from feeder into gin stand.

Float board: The flap at the back of the roll box in an automatic roll-density control on a cotton gin.

Gin stand: Machine for separating lint from seed.

Green boll: A cotton boll that is neither dry nor open.

Heat: A form of energy; that energy which causes a body to rise in temperature. Heat energy is transferred by virtue of a temperature difference. The engineering unit of heat is the British thermal unit (B.t.u.).

Heater: Unit for supplying heat to cotton drier.

Huller breast: The front to which the huller ribs are attached.

Huller ribs: The front set of ribs in a double-rib gin.

I.S. & B.: Abbreviation for "Independent saw and brush drive."

Lambrequin: The lever of the seed board, or seed fingers in gin stand.

Lay-by herbicide: A chemical weed killer applied at lay-by time, to kill weeds as they attempt to emerge.

Lay-by time: The stage of cotton growth when mechanical cultivation is normally discontinued.

Lint cleaner: Machine for removing foreign matter from lint cotton.

Lint flue: Flue or pipe to carry off ginned lint.

Lint moisture content: The percentage of moisture in the fiber based on the wet weight. Lint moisture percent:

$$\frac{\text{Wet weight} - \text{dry weight} \times 100}{\text{wet weight}}$$

Lint regain: The percentage of moisture in lint based on its dry weight. Regain percent:

$$\frac{\text{Wet weight} - \text{dry weight} \times 100}{\text{dry weight}}$$

Magnet: A magnetic device used in various locations in the ginning system to remove metal objects from the cotton.

Moisture content: The ratio of the weight of moisture contained in a sample to the weight of the wet sample, expressed as a percentage; that is—

$$\frac{\text{Weight of moisture in sample} \times 100}{\text{Weight of wet sample}} = \text{Moisture content in percent}$$

When using gravimetric or oven-drying method of moisture determination, this formula becomes:

$$\frac{(\text{Original sample weight}) - (\text{Dry sample weight}) \times 100}{(\text{Original sample weight})} = \text{Moisture content in percent}$$

This is sometimes given as moisture content, wet basis, to differentiate from the amount of moisture in a sample computed as the ratio of the weight of moisture in the sample to the weight of dry material in the sample expressed as a percent. The latter does not have a universal designation and is variously called "moisture content, dry basis," "regain," and "moisture ratio." In the ginning industry, moisture content refers to the wet basis computation. However, the use of moisture content, dry basis, is preferred when making drying studies because it simplifies computations. When using the wet basis method, both the moisture content and the base on which it is computed change during drying; whereas the base remains constant when using the dry basis moisture content. Moisture content, wet basis, may be converted to dry basis by the formula:

$$\frac{100 \times (\text{moisture content, wet basis, in percent})}{100 - (\text{moisture content, wet basis, in percent})} = \text{Moisture content, dry basis}$$

Mote: Immature seed with short, immature fiber attached.

Mote board: A partition, usually movable, to deflect motes.

Moting: The casting out of motes. May be done by gravity or by centrifugal force.

Multipath drier: A drier with several paths to provide various exposure times, to afford proper removal moisture from damp cotton.

Naps: Large entanglements of cotton fiber.

Neps: Small, pinhead size entanglements of fibers in cotton, which show up in ginned lint, card web, yarns, and cloth. Neps are objectionable in the textile industry because they may cause yarn breakages and improper dyeing.

Overflow: Excess cotton fed into the ginning system, which accumulates at a point provided for such overflow of cotton.

Parallel flow drier: The type of drier in which both the hot air and the material to be dried enter the same end of the drier and move in the same direction. Means the same as "concurrent flow."

Pattern of bagging: The two pieces of material used when pressing to cover cotton bales. Each piece is usually about 6 feet long and 36 inches wide.

Picker: An extractor. A harvester on the farm.

Picker roll: A special beating or extracting roller in the front, or breast, of a cotton gin.

Picker-type harvester (or spindle picker): A harvesting machine that removes cotton from the bur with rotating spindles, leaving unopened bolls on the plant; thus also described as a "selective" harvester.

Picking head (or drum): The part of a spindle picker where the cotton is removed from the plant and placed in a conveying system.

Plant lifters: Guides or fingers that lift lower branches and guide the cotton plant into the harvester.

Pneumatic elevator: The upper part of a pneumatic gin. Now seldom used in the United States.

Post-emergence herbicide: A weed-killing chemical applied soon after cotton emerges as a directed spray on small weeds but below the cotton leaves.

Pre-emergence herbicide: A residual weed-killing chemical applied to the soil for several weeks before the cotton emerges, which will kill weeds as they try to emerge.

Press: Bale press. May be either "low-density" or "standard-density" type.

Pressure plates: The hinged, spring-loaded, metal wall opposite the picker spindles that presses the plant toward the spindles.

Raingrown cotton: Cotton grown in areas where rainfall is sufficient and irrigation is not needed.

Ram: The hydraulic lifting and compressing element of a press.

Relative humidity: A measure of the dryness or dampness of air; is defined as the part or fraction of invisible water, in the form of vapor, actually present in air as compared with the maximum moisture the air can hold at a given temperature and atmospheric pressure, without the water vapor condensing into droplets. It is expressed as a percentage. It is also defined as the ratio of the pressure exerted by the water vapor in the air (called the partial pressure of water vapor) to the pressure of saturated water vapor at the same temperature. When air is saturated with water vapor, its relative humidity is said to be 100 percent; if it contains three-fourths as much water vapor, its relative humidity is 75 percent. A relative humidity of zero signifies that the air contains no water vapor.

Rembert fan: Fan that allows seed cotton to pass through, without damaging seed or fiber.

Roll box: Seed-roll box, a compartment holding the seed cotton in contact with the gin saws.

Rock and boll trap: A device for separating heavier materials from seed cotton.

Rolling bales: Cotton bales that are unevenly packaged from a weight distribution standpoint at the gin and that roll out of shape during the re-pressing operation at the compress unless supported by side doors.

Seed belt: A moving belt provided in the gin to convey seed away from the gin stands.

Seed board: Adjustable, fingered plate at bottom of roll box.

Seed cotton: Harvested cotton before the lint is removed from the seed.

Seed cotton mass: Harvested material in the trailer including seed cotton, plant material, and other foreign matter.

Seed cotton moisture content: The quantity of moisture in seed cotton usually expressed in percent. Includes moisture in fiber and in seed.

Seed drier: Apparatus for lowering the moisture content of cottonseed.

Seed-o-meter: Trade name of a device for automatically measuring cottonseed concurrently with the ginning process.

Seed-roll: Roll of seed cotton in the roll box.

Separator: A machine to separate seed cotton from the air currents of the suction fan.

Serpentine cleaner: A seed cotton cleaner, having no moving parts, that removes trash from airborne cotton.

Specific heat: The heat measured in British thermal units (B.t.u.) required to raise 1 pound of material 1° F. The specific heat of air is 0.24 B.t.u. per pound per ° F.; that is, 0.24 B.t.u. applied to 1 pound of dry air will raise its temperature 1° F. The specific heat of cotton has been given as approximately 0.3 B.t.u. per pound per ° F.

Specific weight: The weight of an object in relation to its volume. Commonly expressed as pounds per cubic foot.

Spindle bars: Picker spindles mounted in a vertical tubular housing called a bar.

Spindle moistening pads: Rubber pads through which water is applied to moisten picker spindles as they pass by.

Spindle twists: Small tufts of cotton twisted tightly into a wad.

Stick machine: A device for removing sticks and green leaf from seed cotton.

Stripper-type harvester: A harvesting machine that pulls or strips all cotton bolls, open and unopen, from the plant.

Stripping rolls: Two tubular rolls or one roll and a stationary bar in a stripper-type harvester that remove bolls by passing the plant through a narrow slot between them.

Telescope: Telescopic wagon suction pipe for ready unloading.

Temperature: The degree of hotness or coldness, measured with a thermometer. Temperature is not heat but is a measure of the heat condition of a body or material.

Tramper: Part of the press mechanism. Known also as a packer.

Turnrow: The unplanted space on each end of a field to allow for turning of machinery.

Two-sided bale: A cotton bale that contains lint of one grade or staple length on one side and lint of a different grade or staple length on the other side.

Vacuum wheel or feeder: An apparatus that seals an opening against air leakage while allowing materials to pass.

Vapor pressure: The pressure exerted by pure vapor in equilibrium with the substance named. For example, the vapor pressure of water at 212° F. is 29.92 inches of mercury at sea level, or one atmosphere; and is the pressure of water vapor in equilibrium with liquid water at 212°.

Wetting agent: A surfactant or detergent added to the water for spindle moistening to improve spindle cleaning.

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